CLEANING UP AMERICA'S NUCLEAR WEAPONS COMPLEX

2019 Update for Governors

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ACKNOWLEDGEMENTS

The authors of "Cleaning Up America's Nuclear Weapons Complex: 2019 Update for Governors" are Dan Lauf, program director, and Bevin Buchheister, senior policy analyst in the National Governors Association Solutions: Center for Best Practices' (NGA Solutions) Energy, Infrastructure & Environment policy team. This report was written with assistance from Andy Chinn, Molly Spiller and Heather Martin from Ross Strategic.

The authors would like to thank the U.S. Department of Energy Office of Environmental Management (DOE EM) for its partnership and funding support for the report. We also would like to thank the members of the NGA Solutions Federal Facilities Task Force for their time and effort reviewing draft versions of the report and providing updated, state-specific information. We also thank the following individuals for their careful review of and contributions to this report: Sue Gander, Alex Schaefer and Anne Clement of NGA and Elizabeth Lisann of DOE EM.

This report was completed with support from DOE EM under Award Number DE-EM0005173.

D-Reactor complex, Hanford Nuclear Reservation, Washington State. D-Reactor was one of three production reactors constructed at Hanford during the Manhattan Project and World War II. Photo courtesy of Library of Congress, Prints & Photographs Division, HAER, Reproduction number HAER WASH,3-RICH.V,1–14.

Executive Summary

The research, testing and production of America's nuclear arsenal that began during World War II and continued throughout the Cold War was critical to U.S. national security. However, this work resulted in significant environmental contamination at sites across the country. That contamination is now the focus of the largest environmental cleanup effort in the world. The U.S. Department of Energy Office of Environmental Management (DOE EM) spends more than $6 billion per year to fund cleanup activities and manage the cleanup sites. States play an important role in the cleanup partnership, overseeing the cleanup effort and working with DOE EM to ensure that federal and state laws are followed and that cleanup decisions are transparent, responsible and equitable. The National Governors Association (NGA) Solutions: Center for Best Practices' Federal Facilities Task Force (FFTF) is a forum in which states directly affected by the cleanup effort can communicate with each other and with DOE EM on waste disposal progress, priorities and challenges and stay informed about technology, policy and budget developments. The FFTF includes Idaho, Kentucky, Missouri, Nevada, New Mexico, New York, Ohio, Oregon, South Carolina, Tennessee, Texas and Washington.

Important progress has been made since DOE EM was established in 1989 and the FFTF was founded in 1993, including the establishment of legal frameworks and agreements for cleanup, completion of cleanup operations at 91 of 107 total sites and significant reduction in risk to public health and the environment at all the sites.[1] In addition to successes across the complex, significant cleanup progress has been made in each FFTF state that hosts cleanup sites.

[1] U.S. Department of Energy, Office of Environmental Management. (n.d.) Retrieved from https://www.energy.gov/em/office-environmental-management.

Successes from each state are contained in the body of this report. Major highlights since NGA last published this report in 2015 include:

- The first-ever demolition of a gaseous diffusion plant in **Tennessee** in 2016.
- Completion of **Idaho's** Transuranic Storage Area-Retrieval Enclosure cleanup in 2017.
- Early transfer of land and facility to a private developer for remediation and redevelopment in **Missouri** in 2017.
- Final cleanup of the Hanford hazardous waste burial grounds in **Washington** in 2018.
- Land transfer for community reuse in **Ohio** in 2018.
- Demolition of the West Valley vitrification plant in **New York** in 2018.
- Restarting waste disposal in 2017 at the Waste Isolation Pilot Plant in **New Mexico** after operations were suspended in 2014 because of an accident and radiation release.

Progress continues, but substantial work remains. Completing the cleanup is projected to cost $380 billion[2] (in 2018 dollars) and take at least another 50 years, assuming that all technical, regulatory and funding challenges are overcome.

Each site has its own unique environmental and regulatory challenges, but the states share the following five priority issues:

Jointly Setting Funding Priorities. States have worked with DOE EM to ensure that funding is sufficient to meet cleanup requirements and that budget decisions are made transparently and in consultation with states. Because funding for cleanup fluctuates, however, and cannot cover every project in the DOE EM portfolio, it is important for DOE EM to proactively seek state input on cleanup project priorities and communicate to states the effect that deferred cleanup will have in the short term on the ultimate cost and timeline for completing cleanup. ***The FFTF encourages DOE EM to set priorities jointly with states during budget shortfalls by using the principles developed by the FFTF that incorporate "risk plus other factors" as a priority-setting framework.***[3]

Ensuring Compliance. Existing agreements between states and DOE EM that establish cleanup plans and timetables also establish cleanup milestones and provide states with legal recourse when cleanup is not adequately progressing. Understanding whether and how DOE EM will meet its compliance requirements and how it will respond if it cannot do so is a crucial element of state oversight. State concerns with compliance also include determining levels of cleanup that will be protective over the long term, enabling effective state oversight, including appropriate roles for risk in decision making and ensuring that DOE EM assesses and compensates for damage to natural resources. ***The FFTF encourages pursuit of site cleanup levels that allow for public reuse and, if waste must be left in place, application of long-term stewardship to protect human health and the environment. The FFTF encourages risk-informed decision making, open and transparent communication from DOE EM on long-term planning and transparency when DOE EM is in jeopardy of missing compliance milestones. The FFTF also encourages DOE EM's fulfillment of obligations under the Natural Resource Damage Assessment and restoration process.***

Managing Waste Safely. States and DOE EM have worked together to make transparent, equitable decisions about the treatment, transportation, and disposal of radioactive waste. States continue to work with DOE EM to ensure that all parties manage all waste types according to DOE's internal management guidelines, transport waste safely and appropriately monitor sites with long-term contamination. ***The FFTF supports DOE's efforts to develop interim storage and permanent disposal options for high-level waste (HLW) that have the consent of host states and to coordinate transportation with affected states.*** DOE is currently considering changing the way it classifies waste in Order 435.1: Radioactive Waste Management. DOE proposes basing waste classification on its radioactive characteristics rather than the current method of basing it on the source of the waste and its method of production. States are concerned that this

[2] U.S. Government Accountability Office. (2018, March 14). *Testimony before the Subcommittee on Strategic Forces, Committee on Armed Forces, U.S. Senate. Department of Energy: Continued actions needed to address management challenges* (Report GAO-18-1438T). Washington, DC. Retrieved from https://www.gao.gov/assets/700/690660.pdf.

[3] See Appendix E for the FFTF's full principles.

change could affect agreed-upon strategies and locations for waste disposal. ***The FFTF encourages DOE to consult with states to understand the impact that a change in waste classification methodology will have on compliance agreements and on the ultimate disposition of waste.***[4]

Improving Communication. The FFTF is concerned about unclear processes for discussing concerns with DOE EM and lack of notification on key issues. States have several avenues for communicating concerns, such as advisory boards and local DOE EM site offices, but the FFTF questions whether current forums are adequate to elevate major or long-standing disputes. ***The FFTF supports establishing direct communications channels and protocols with DOE EM to elevate and resolve major and long-standing disputes.***

Developing Uniform Emergency Response Communication Protocols. With the proliferation of smartphones and social media, information, misinformation and unauthorized photographs can be shared rapidly on the internet and national television. During an emergency, it is critical that intergovernmental partners and the public receive correct information and for misinformation to be dispelled quickly. ***The FFTF suggests that DOE EM, in coordination with the states and other parties, develop a uniform public communications protocol for emergency situations that recognizes rapid dissemination of information in the age of social media.***

The development of America's nuclear weapons program lasted several decades and directly affected communities across the country. Cleaning up the program's environmental legacy will take many more decades, cost billions of dollars and require a strong partnership between the states and the federal government to complete. Despite the high cost, lengthy timeline, and other challenges, states appreciate and are committed to their partnership with DOE EM to ensure the success of the cleanup mission. The FFTF looks forward to helping maintain this strong state-federal partnership, which will ultimately result in greater protections for human health and the environment for generations to come.

[4] U.S. Department of Energy, Office of Environmental Management. (2018, October 10). Request for public comment on the U.S. Department of Energy interpretation of high-level radioactive waste. *Federal Register*. Retrieved from https://www.federalregister.gov/d/2018-22002.

Mound Site, Miamisburg, Ohio. The facility operated from 1948 to 2003 and supported various DOE weapons and energy programs throughout its existence. Photo courtesy of Library of Congress, Prints & Photographs Division, HABS, Reproduction number HABS OH-2470-D-1

Introduction

America's nuclear weapons complex, developed during World War II and expanded throughout the Cold War, provided important U.S. security benefits. It also created a significant environmental cleanup legacy that spanned 107 sites and 35 states and will require decades to complete. The U.S. Department of Energy (DOE) oversees the cleanup effort in coordination with regulators in states that host or are adjacent to active cleanup sites.

In 1992, Congress passed the Federal Facilities Compliance Act (FFCA).[5] The FFCA required DOE to report on the inventory of waste at its contaminated sites and to propose cleanup plans for state review and approval. The FFCA also gave states additional regulatory and oversight authority, allowing them to levy fines on DOE for failure to comply with agreements, and required that DOE's cleanup adhere to federal environmental laws.[6] Today, DOE's Office of Environmental Management (EM), created in 1989, oversees a significant portion of the cleanup effort alongside state regulators. Following closure, sites may require long-term stewardship (LTS), including surveillance and maintenance, often while being repurposed for other uses.

COMBINED INTERGOVERNMENTAL WORKING GROUP

To facilitate open dialogue across all levels of government, the NGA, in partnership with DOE EM, facilitates the Combined Intergovernmental Working Group (CIWG), which is made up of six state, community and tribal organizations and DOE EM. These organizations include the Energy Communities Alliance, the Environmental Council of the States, the National Association of Attorneys General, the NGA FFTF, the National Conference of State Legislatures Nuclear Legislative Working Group and the State and Tribal Government Working Group. The CIWG holds conference calls quarterly to coordinate activities and priorities. Since 2003, the six intergovernmental groups have also met annually with DOE EM in a combined intergovernmental meeting to foster open dialogue, transparency and coordination.

[5] Federal Facility Compliance Act of 1992, 102d Cong. (1992) (enacted). Retrieved from https://www.govinfo.gov/content/pkg/STATUTE-106/pdf/STATUTE-106-Pg1505.pdf.
[6] See Appendix B for more information on how cleanup decisions are made.

Federal Facilities Task Force

To ensure achievement of the FFCA's goals, the National Governors Association (NGA) Solutions: Center for Best Practices established the Federal Facilities Task Force (FFTF) in 1993 to help governors address challenges and improve coordination with DOE EM. The FFTF currently consists of governor-appointed policy and technical representatives from 12 states (**Idaho**, **Kentucky**, **Missouri**, **Nevada**, **New Mexico**, **New York**, **Ohio**, **Oregon**, **South Carolina**, **Tennessee**, **Texas** and **Washington**).

One of the FFTF's first activities was to coordinate the development of the initial site treatment plans under the FFCA. That process included discussions of equity among the states because some waste would need to be disposed of in other states. Based on the successful collaboration that immediately followed the FFCA site treatment plan process, The FFTF continued to interact regularly with each other and with DOE EM to discuss cleanup progress and explore new technical and policy issues.

The FFTF convenes regularly through bimonthly conference calls and semiannual meetings to coordinate cleanup priorities and activities among the states and with DOE EM and other intergovernmental groups. The FFTF examines critical technical, policy and budget issues and improves coordination among major program decisions on a range of issues related to radioactive material and waste.[7] It also participates in the annual meeting of the CIWG, which is made up of six state, community and tribal organizations and DOE EM (see box on previous page) to discuss critical issues and coordinate activities.

Figure 1 shows the remaining major cleanup sites in the FFTF and highlights states that are members of the FFTF. Also included are DOE's estimated completion dates for final closure of each site. Missouri, Texas and Oregon do not have active cleanup sites run by DOE EM but are members of the FFTF because of their proximity to other DOE EM cleanup sites and because they engage in activities relevant to the group. Sites not shown on the map include Brookhaven National Laboratory and the Separations Process Research Unit in New York, the Energy Technology Engineering Center and Lawrence Livermore National Laboratory in **California** and the Moab Uranium Mill Tailings Remedial Action project in **Utah**.

[7] For more information about the FFTF, see Appendix F.

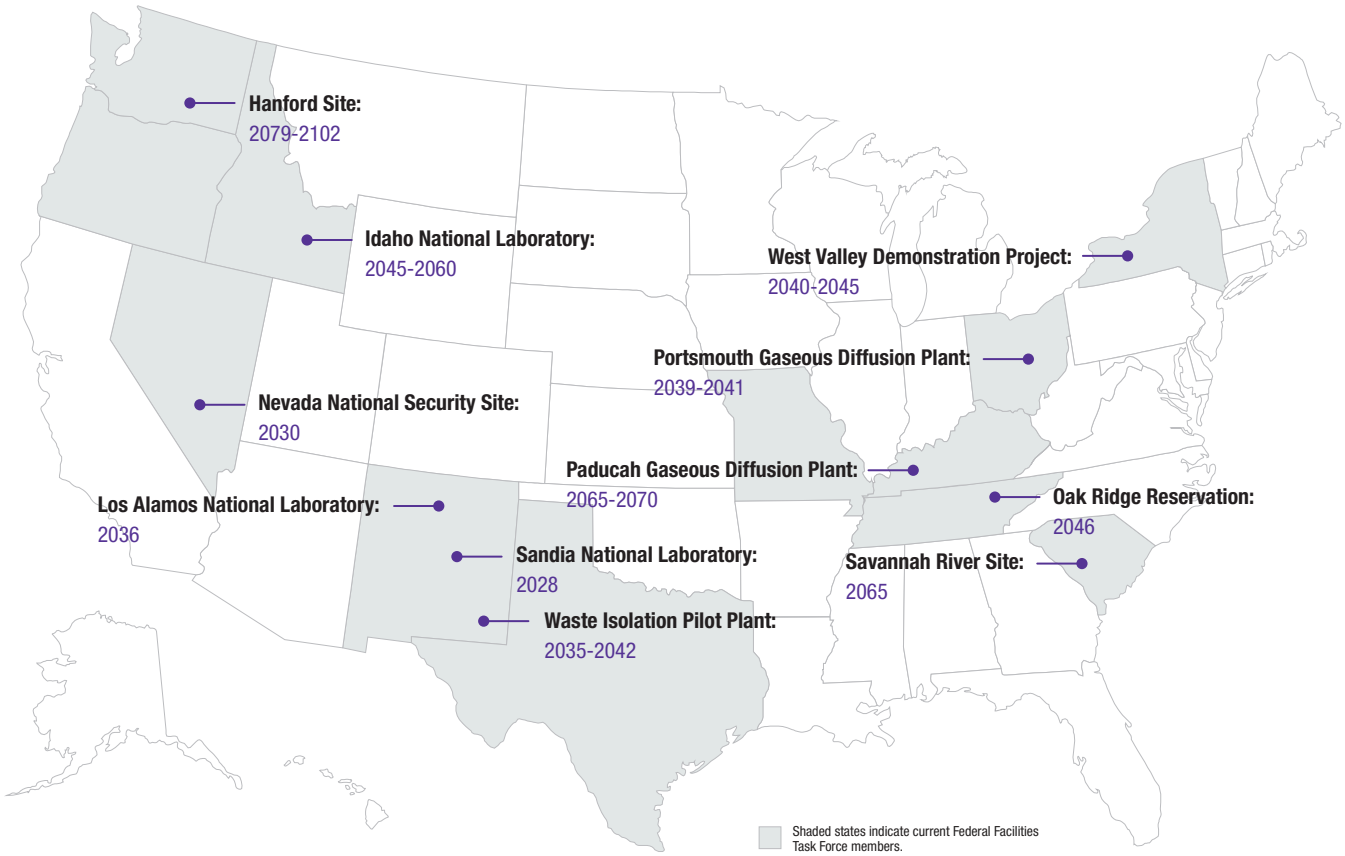

FIGURE 1: Map of the major DOE EM sites undergoing cleanup in the FFTF and the estimated completion dates for final closure of those sites. All FFTF states, including those without active cleanup sites, are highlighted.[8]

[8] Closure dates shown are DOE EM estimates for completion of cleanup at these major sites, as reported in DOE's fiscal 2019 budget request to Congress. Several caveats apply: (1) Several sites — Los Alamos National Laboratory, Idaho National Laboratory, Nevada National Security Site, Oak Ridge Reservation, Sandia National Laboratory and Savannah River Site — have ongoing missions. Because these sites will not close, the dates shown reflect completion of cleanup. (2) The Waste Isolation Pilot Plant in New Mexico is currently functioning as a disposal facility and is not undergoing cleanup. However, it is expected to fulfill its mission and close within the range of dates shown. (3) In other cases, like at the West Valley Demonstration Center in New York, closure dates are interim estimates, with final closure dates yet to be defined pending forthcoming Records of Decision. (4) In several cases, projected closure dates do not match dates that are in current compliance agreements with states for completion of all required cleanup. U.S. Department of Energy. (2018, March). *Department of Energy FY 2019 congressional budget request: Environmental management*. Retrieved from https://www.energy.gov/sites/prod/files/2018/03/f49/DOE-FY2019-Budget-Volume-5_0.pdf; U.S. Department of Energy. (2019). 2019 Hanford lifecycle scope, schedule and cost report (Report DOE/RL-2018-45). Retrieved from https://www.hanford.gov/files.cfm/2019_Hanford_Lifecycle_Report_w-Transmittal_Letter.pdf.

Waste Calcining Facility, Idaho. The Waste Calcining Facility operated from November 1963 to March 1981 and converted 4,091,000 gallons of aqueous radioactive waste into 77,300 ft3 of calcined solids. Photo courtesy of Library of Congress, Prints & Photographs Division, HAER, Reproduction number HAER ID,12-SCOVI.V,1C-2

Successes Around the Complex

Since the 1992 enactment of the FFCA, DOE and states have worked together to clean up the nuclear weapons complex. To date, they have completed cleanup at 91 sites across the United States. Examples of successful efforts across the nuclear weapons complex since this report was last issued in 2015 include:

- Completion of the first ever demolition of a gaseous diffusion plant demolition in Tennessee in 2016.
- Completion of the Idaho Transuranic Storage Area-Retrieval Enclosure (TSA-RE) transuranic (TRU) waste cleanup effort in 2017.
- Early transfer of land and facility to a private developer for remediation and redevelopment in Missouri in 2017.
- Final cleanup of Hanford hazardous waste burial ground in Washington in 2018.
- Land transfer for community reuse in Ohio in 2018.
- Demolition of the West Valley vitrification plant in New York in 2018.
- Restarting waste disposal at the Waste Isolation Pilot Plant (WIPP) in New Mexico in 2017 after operations were suspended in 2014 because of an accident and radiation release.

Additional details on cleanup successes are noted below. Other cleanup successes are included in the state-specific sections of this guide starting on page 18. Earlier cleanup successes at each site have been covered in detail in past reports.

Cleanup Successes

Tennessee: First-Ever Demolition of a Gaseous Diffusion Plant Completed

In August 2016, DOE EM contractors tore down the final portion of the Oak Ridge Gaseous Diffusion Complex. This historic milestone marked the first completed demolition of a gaseous diffusion project in the world. The original K-25 gaseous diffusion plant began operations in 1942 as part of the Manhattan Project and produced weapons-grade enriched uranium. DOE added several more buildings to Oak Ridge diffusion operations during the Cold War,

creating a massive complex of buildings to support enrichment activities.[9] The site of the gaseous diffusion complex is now known as the East Tennessee Technology Park (ETTP). As EM cleans up various ETTP sections, the land is transferred to the city of Oak Ridge and the Community Reuse Organization of East Tennessee for reuse as a brownfield industrial complex.[10]

Idaho: Completion of Waste Retrieval at TSA-RE

In early 2017, DOE EM completed activities at TSA-RE, a building with a seven-acre footprint that housed DOE's largest stockpile of legacy TRU waste for more than 20 years. The TRU stockpile consisted of more than 50,000 cubic meters (m^3) of metal drums and boxes buried under an earthen berm. Excavation and retrieval activities at TSA-RE began in 2003, and all drums and boxes retrieved will eventually be repackaged and prepared for shipment out of Idaho for final disposal.[11]

Missouri: Early Transfer of Land and Facility to a Private Developer

DOE and the U.S. General Services Administration (GSA) jointly owned and managed the 300-acre Bannister Federal Complex in Kansas City, Missouri, for more than 70 years until 2017, when the property was transferred to Bannister Transformation & Development LLC. The transition was completed under the "early transfer" process, whereby a federal property can be transferred prior to completion of remedial action. The private developer will perform environmental restoration on-site and demolish obsolete buildings, with oversight from Missouri Department of Natural Resources. Transfer of the site to a private entity for demolition and remediation is expected to provide significant savings to the federal government.[12]

Office of Legacy Management

Ideally, waste and other hazards are fully removed from a contaminated site so that the land can be released for unrestricted use. That approach avoids engineered or institutional controls that require ongoing funding and are vulnerable to failure over the long-term. However, it is not always feasible to restore sites to unrestricted use because the associated costs or risks to cleanup workers would outweigh the marginal reduction in risk of such an approach. The residual contamination of those sites presents a danger to human health and the environment that requires long-term management.

With state support, DOE established the Office of Legacy Management (LM) in 2003 to manage responsibilities after site closure and ensure future protection of human health and the environment. As of 2018, DOE LM is responsible for 92 sites, with the number projected to increase to 123 sites by fiscal 2033 (see https://www.energy.gov/lm/office-legacy-management). DOE LM activities include maintaining all engineered and institutional controls designed to contain or prevent exposure to residual contamination and waste, record-keeping activities, groundwater and surface water monitoring and emergency response. Although some smaller sites that DOE LM manages did not require complicated or lengthy closure plans, several sites, including Mound, Ohio, and Weldon Springs, Missouri, are notable for the technical and funding hurdles that needed to be overcome to achieve closure.

[9] U.S. Department of Energy, Oak Ridge Office of Environmental Management. (2016, August 30). *DOE completes decade-long project at Oak Ridge gaseous diffusion complex* [Press release]. Retrieved from https://www.energy.gov/orem/articles/doe-completes-decade-long-project-oak-ridge-gaseous-diffusion-complex.

[10] World Nuclear News. (2016, February 12). Final demolition starts at Oak Ridge diffusion facility. Retrieved from http://www.world-nuclear-news.org/Articles/Final-demolition-starts-at-Oak-Ridge-diffusion-fac.

[11] U.S. Department of Energy. (2017, March 15). *Transuranic waste retrieval at Idaho's AMWTP now complete* [Press release]. Retrieved from https://www.energy.gov/em/articles/transuranic-waste-retrieval-idaho-s-amwtp-now-complete.

[12] Kansas City National Security Campus. (2017, December 18). NNSA completes transfer of Bannister Federal Complex to private developer for demotion, remediation and redevelopment [Press release]. Retrieved from https://kcnsc.doe.gov/news/latest-news/2017/12/19/nnsa-completes-transfer-of-bannister-federal-complex-to-private-developer-for-demolition-remediation-and-redevelopment.

Washington: Final Cleanup of Hanford Hazardous Waste Burial Ground

During the Cold War, DOE developed and manufactured reactor fuel for plutonium production at the 300 Area of the Hanford site in eastern Washington. Hazardous waste from the 300 Area was buried in the 618-10 burial grounds in pipes, drums, boxes and bottomless tanks, and much of the soil surrounding the grounds was highly contaminated.[13] In mid-2018, DOE EM, the Washington State Department of Ecology and the U.S. Environmental Protection Agency (EPA) certified cleanup at the 618-10 area complete. This intense, eight-year effort involved removal of more than 512,000 tons of contaminated soil and waste debris.[14] DOE EM contractors will work on returning the 618-10 site to a natural state, including planting native species.

Ohio: First Parcel of Federal Property Transferred for Community Reuse

In July 2018, DOE EM transferred 80 acres of federal land to the Southern Ohio Diversification Initiative (SODI), a community reuse organization for the Portsmouth Site. The land is the first to become available for transfer since decontamination and decommissioning began at the Portsmouth Gaseous Diffusion Plant in 2011. SODI will use the land for local economic development initiatives.[15]

New York: Completed Demolition of West Valley Vitrification Plant

In 2018, DOE EM contractors completed deactivation and demolition of the vitrification facility at New York's West Valley site, marking the first time a vitrification facility at a DOE EM site had completed its mission, from startup to demolition (Figure 2). The vitrification facility at the West Valley site operated from 1996 to 2002; during that time it converted 600,000 gallons of high-level liquid radioactive waste into solid form by mixing the waste with glass-forming materials, heating the mixture to form molten glass and pouring the molten glass waste material into stainless steel canisters to cool and solidify.[16]

FIGURE 2: Demolition of the West Valley Vitrification Plant. Photo courtesy of U.S. Department of Energy.

New Mexico: Resumed WIPP Operations

WIPP in New Mexico began receiving shipments of remote-handled TRU waste in 2007 and continued to do so until 2014, when two safety incidents (an underground salt haul truck fire on Feb. 5, 2014, and an underground radiological release on Feb. 14, 2014) resulted in suspension of regular shipping and disposal operations.[17] In April 2017, WIPP resumed operations and began receiving waste shipments for disposal in the facility's underground salt tunnels (Figure 3). As of September 2018, WIPP had received 12,259 waste shipments from 13 sites across the country.[18]

FIGURE 3: Excavation of the WIPP disposal room. Photo courtesy of U.S. Department of Energy.

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[13] U.S. Department of Energy. (2018, May 13). Hanford 300 Area. Retrieved from https://www.hanford.gov/page.cfm/300area.

[14] U.S. Department of Energy. (2017, November 30). *Workers finish cleaning up high-hazard waste site near Richland* [Press release]. Retrieved from https://www.hanford.gov/news.cfm/DOE/618-10_wrap_up.pdf.

[15] First parcel of land to be transferred at DOE site. (2018, July 5). T*he Pike County (New York) News Watchman*. Retrieved from https://www.newswatchman.com/news/article_a085e58f-9eaf-51aa-80b1-35b62afa2dad.html.

[16] U.S. Department of Energy. (2018, September 25). *EM crews successfully complete major demolition at West Valley* [Press release]. Retrieved from https://www.energy.gov/em/articles/em-crews-successfully-complete-major-demolition-west-valley.

[17] U.S. Department of Energy, Office of Environmental Management. (2014). *Accident investigation report: Underground salt haul truck fire at the Waste Isolation Pilot Plant.* Retrieved from http://www.wipp.energy.gov/Special/AIB Report.pdf. See also U.S. Department of Energy. (2014, February 14). *Accident investigations of the February 14, 2014, radiological release at the Waste Isolation Pilot Plant, Carlsbad, NM* [Press release]. Retrieved from https://www.energy.gov/ehss/downloads/accident-investigations-february-14-2014-radiological-release-waste-isolation-pilot.

[18] Waste Data System. (2019, April 17). *Waste Isolation Pilot Plant: WIPP status report*. Retrieved from http://www.wipp.energy.gov/general/GenerateWippStatusReport.pdf.

Site Closures

States and DOE EM share the goal of safely closing all sites in the nuclear weapons complex. "Site closure" is defined as the completion of cleanup to safe and acceptable levels so that only long-term monitoring and stewardship are required rather than active cleanup operations. DOE EM and the states have made substantial progress cleaning up and closing contaminated sites. A total of 91 of the 107 sites have been closed, 80 of which were closed after the establishment of DOE EM in 1989.[19] As of early 2019, four large sites have been successfully closed: the Weldon Spring Site in Missouri, Fernald in Ohio, Rocky Flats in Colorado, and Mound in Ohio.

Missouri: Weldon Spring

Weldon Spring in Saint Charles, Missouri, operated from the mid-1950s to 1967 and included a chemical plant that converted processed uranium ore concentrates. Wastes generated during these operations resulted in significant radiological contamination, and the site was placed on the National Priorities List (NPL) in 1987.[20] Site cleanup, which began in the late 1980s, resulted in a 41-acre disposal cell surrounded by 150 acres of restored native prairie. Weldon Spring was transferred to DOE LM in 2003.[21]

Ohio: Fernald

Like Rocky Flats, the Fernald Closure Project is a successful example of an accelerated cleanup process. The Fernald site, 18 miles from Cincinnati, produced approximately 500 million pounds of low enriched uranium for use at other government facilities involved in the production of nuclear weapons from the early 1950s through the late 1980s.[22] A 1992 report forecasted completion of cleanup in 2019 at a cost of $12.2 billion; accelerated cleanup, including the removal of more than a million tons of radioactive material and the demolition of 323 buildings, reduced the final cost to $4.4 billion.[23] DOE EM completed the closure and transition to DOE LM in 2006. Following soil cleanup, restoration ecologists developed nearly 400 acres of woodlots, 327 acres of prairie, more than 140 acres of open water and wetlands, and 33 acres of savanna, restoring the area to an undeveloped park with an emphasis on wildlife and education (Figure 4).[24]

FIGURE 4: Fernald Site in 1987 (left) and 1990 (right). Photos courtesy of U.S. Department of Energy.

[19] The complete list of sites is available at U.S. Department of Energy, Office of Environmental Management. Cleanup sites. Retrieved from https://www.energy.gov/em/cleanup-sites.
[20] U.S. Department of Energy. (2013). *2012 Annual inspection report for the Weldon Spring, Missouri* [page 2]. Retrieved from https://www.lm.doe.gov/Weldon/ir_wel.pdf.
[21] U.S. Department of Energy, Office of Legacy Management. (2019, March 11). *Weldon Spring fact sheet*. Retrieved from https://www.lm.doe.gov/WorkArea/linkit.aspx?LinkIdentifier=id&ItemID=11975.
[22] Fluor Corporation. (2007, January 29). *Fluor receives formal acceptance from U.S. Department of Energy; Fernald clean-up is complete* [Press release]. Retrieved from http://www.lm.doe.gov/land/sites/oh/fernald_orig/NewsUpdate/pdfs%5CFluor Fernald ReceiFormal DOE Acceptance.pdf.
[23] U.S. Department of Energy, Office of Legacy Management. *Fernald Preserve, Ohio* [Fact Sheet]. Retrieved from https://www.lm.doe.gov/WorkArea/linkit.aspx?LinkIdentifier=id&ItemID=7241.
[24] U.S. Department of Energy, Office of Legacy Management. (2018, November). *Mound, Ohio* [Fact Sheet] Retrieved from https://www.lm.doe.gov/Mound/Fact_Sheet-Mound.pdf.

Colorado: Rocky Flats

From 1952 to 1994, the Rocky Flats facility, 16 miles from downtown Denver, produced components for the U.S. nuclear arsenal. The site primarily produced the plutonium pit or trigger for nuclear weapons, generating substantial environmental contamination and cleanup challenges (Figure 5).[25] DOE EM initially predicted that site closure would take approximately 65 years at more than $37 billion in cleanup costs.[26] Beginning in 1996, DOE EM, its contractor and the state of Colorado worked together to develop a more cooperative cleanup agreement that streamlined the regulatory process and included a performance- and incentive-based contract that set an aggressive target closure date of 2006. With an infusion of additional funding to accelerate the work, DOE EM completed cleanup nearly a year ahead of the accelerated schedule and $7.4 billion under budget. After consultation with state government and other parties, most of the site was transferred to the U.S. Fish and Wildlife Service in 2007.[27] DOE LM is responsible for part of the Rocky Flats site and provides ongoing monitoring and maintenance.

FIGURE 5: Rocky Flats plant circa 1978. The area in which the plant was located is now under authority of the U.S. Fish and Wildlife Service. Photo courtesy of Library of Congress, Prints & Photographs Division, HAER, Reproduction number HAER COLO,30-GOLD.V,1—26.

Ohio: Mound

The Mound site, located in Miamisburg, Ohio, produced polonium-beryllium initiators used in atomic weapons and conducted research related to radionuclides and detonators. The 1990 Federal Facilities Agreement (FFA) (amended in 1993 to include the state of Ohio) established a procedural framework and schedule for developing appropriate responses; it also facilitated cooperation and exchange of information among the agencies. By Sept. 30, 2006, all nuclear material had been shipped off-site, facilities had been demolished or decontaminated and most environmental remediation activities were complete. Responsibility for site management was transferred to DOE LM in 2010.[28]

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[25] U.S. Environmental Protection Agency. (2018, October 23). Superfund site: Rocky Flats plant (USDOE) Golden, CO. Retrieved from https://cumulis.epa.gov/supercpad/cursites/csitinfo.cfm?id=0800360.

[26] U.S. Department of Energy, Rocky Flats Project Office. (2006, August). *Closure legacy: From weapons to wildlife* [pages 1–5]. Retrieved from https://www.lm.doe.gov/land/sites/co/rocky_flats/closure/references/Closure_Legacy_Document.pdf.

[27] U.S. Department of Energy, Office of Legacy Management. (2018, November). *Rocky Flats, Colorado, site* [Fact Sheet]. Retrieved from https://www.lm.doe.gov/WorkArea/linkit.aspx?LinkIdentifier=id&ItemID=2963.

[28] U.S. Department of Energy, Office of Legacy Management. *Fernald Preserve, Ohio, site* [Fact Sheet]. Retrieved from https://www.lm.doe.gov/WorkArea/linkit.aspx?LinkIdentifier=id&ItemID=7241.

Plutonium Recovery Facility, Rocky Flats Plant, Colorado. During operations, the facility was designed for recovery of plutonium from nuclear weapons parts fabrication, component assembly, and research and development activities. Photo courtesy of Library of Congress, Prints & Photographs Division, HAER, Reproduction number HAER COLO,30-GOLD.V,1K-18

What Are the Main Issues of Concern for States?

Since 1993, the FFTF has worked with DOE EM to address individual site concerns and issues of common interest throughout the nuclear weapons complex. The FFTF is focused on five key issues related to environmental cleanup:

- Setting priorities for federal funding to meet agreed-upon, enforceable cleanup milestones.
- Ensuring that cleanup sites comply with federal and state cleanup standards.
- Managing radioactive waste safely, including transportation, disposal and long-term stewardship.
- Improving communication pathways between states, DOE EM sites and DOE EM headquarters.
- Developing uniform emergency response communication protocols to address rapid dissemination of information in the age of social media.

Setting Funding Priorities

Ensuring sufficient funding to clean up the nuclear weapons complex in a manner that appropriately balances short- and long-term needs is a high priority for states. Because funding for cleanup is allocated through the federal budget process, DOE and the president must request and Congress must appropriate sufficient annual funding to meet cleanup commitments and avoid higher future costs. Under Executive Order 12088, DOE is required to request a budget that complies with environmental requirements.[29] However, the order applies only to DOE's initial budget request.[30] Neither the president's budget request nor the budgets developed by congressional appropriators are subject to those requirements. Therefore, those requests could be insufficient to meet all compliance commitments, potentially slowing the pace of remediation of environmental risks in the short term and likely contributing to an increase in the total costs associated with cleanup over the long term. This is particularly important given that a significant portion of

[29] Exec. Order. No 12088, 43 C.F.R. 47707 (1978); 3 C.F.R., (1978) Comp., p. 243.

[30] Executive Order 12088 states: "Each Executive agency shall submit to the Director of the Office of Management and Budget, through the Administrator, an annual plan for the control of environmental pollution. The plan shall provide for any necessary improvement in the design, construction, management, operation, and maintenance of Federal facilities and activities, and shall include annual cost estimates. The Administrator shall establish guidelines for developing such plans… In preparing its plan, each Executive agency shall ensure that the plan provides for compliance with all applicable pollution control standards."

the DOE EM cleanup budget is allocated to "hotel costs" – that is, the minimum funding required to safely maintain the status quo of existing (often aging) infrastructure without advancing progress toward cleanup.

Since the maturation of the cleanup program in the mid-1990s, DOE EM funding levels for cleanup have typically ranged from $6 billion to $8 billion per year, as illustrated in Figure 6 below, with the exception of a $6 billion funding increase in 2009-2010 from the American Recovery and Reinvestment Act (ARRA).[31]

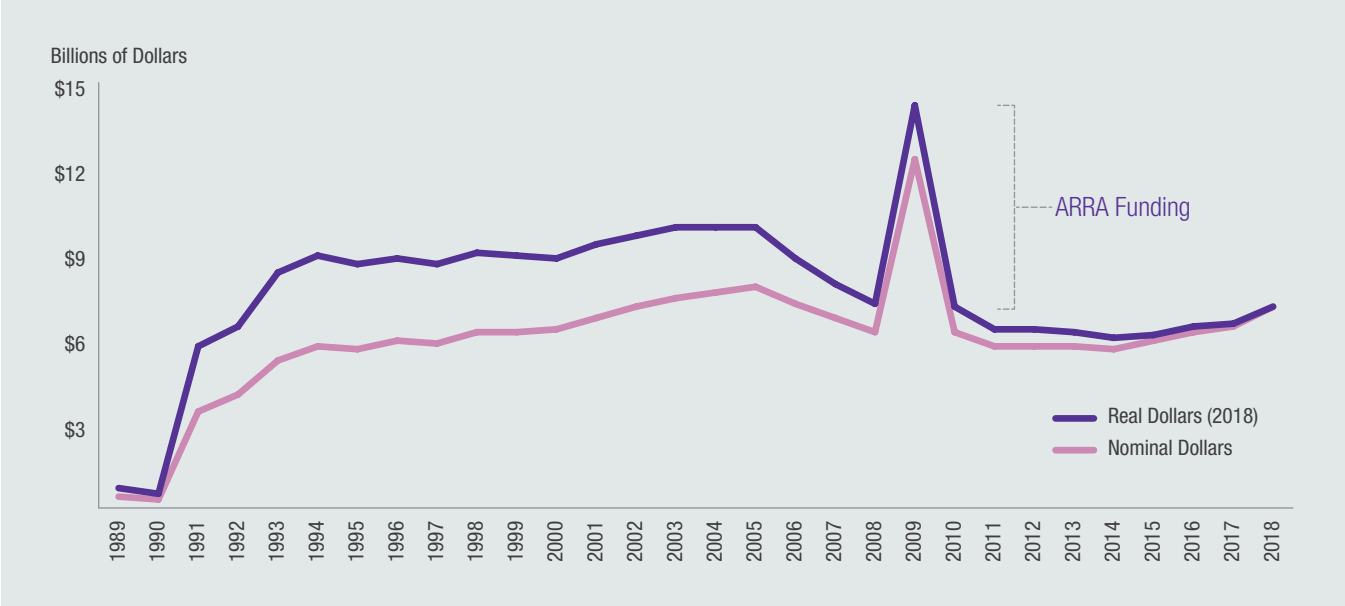

FIGURE 6: DOE EM budget in nominal and real dollars (1989-2018). Source: Data compiled from historical DOE budget statements.

Even with an annual budget between $6 billion and $8 billion, funding is often insufficient to cover every project in the DOE EM portfolio. Thus, jointly developing priorities for projects within sites and across the complex is necessary. In 2012, the FFTF, with input from DOE EM, developed principles to guide the process by which states and DOE EM would jointly set priorities for cleanup projects. In 2017, the FFTF revisited those principles to ensure that they remained aligned with states' goals and needs. The principles provide a framework for state-DOE EM interaction and coordination when compliance milestones will not be met in a given year because of budget shortfalls. They provide an approach that recognizes the significance and legal standing of state-DOE EM agreements and a path forward that uses environmental risk and other factors to determine the order in which cleanup projects should be undertaken. *The FFTF encourages DOE EM to jointly set priorities with states during budget shortfalls by using the principles the FFTF developed that incorporate "risk plus other factors" as a priority setting framework.*[32]

Ensuring Compliance

Since the passage of FFCA, state compliance agreements have been an important tool for achieving cleanup. Specific state concerns with compliance and cleanup include determining cleanup levels that are protective over the long run, enabling effective state oversight, ensuring an appropriate role for risk in cleanup decision making, and assessing damage to natural resources.

[31] Pew Center on Global Climate Change. (2009, December). *U.S. Department of Energy's Recovery Act spending*. Retrieved from https://www.issuelab.org/resources/11536/11536.pdf.
[32] See Appendix E for the FFTF's full principles.

Cleanup Levels

States are concerned about the thoroughness of cleanup efforts—or determining "how clean is clean." Ideally, sites will be cleaned to a level that requires no further restrictions on land use. Unfortunately, cleanup to unrestricted levels is often not technically or financially feasible. At most sites, some level of waste will remain after cleanup, and the amount and type of waste can vary greatly, even within a site. States want to ensure that waste left in landfills, underneath caps or in the soil or groundwater will not eventually threaten the public or the environment. *The FFTF encourages DOE EM to clean sites so that they can serve various land uses, including public reuse. If contamination must be left in place, DOE must maintain and fund long-term stewardship that employs a combination of controls to restrict land use and long-term sampling and surveillance of the remaining contamination.*

FIGURE 7: Cleanup at Hanford in Washington state. Photo courtesy of U.S. Department of Energy.

State Oversight and Compliance Agreements

Meeting compliance milestones is extremely important to states. Under the FFCA, states can oversee the treatment of DOE's waste and some aspects of shipment and disposal to ensure citizens' health and safety as well as environmental protection. States have authority to regulate DOE's mixed hazardous wastes while DOE self-regulates for specific types of radioactive wastes in compliance with a variety of statutes, regulations, directives and guidance for cleanup and disposal. Compliance agreements are mandatory and intended to force action, yet states recognize that changing information and circumstances at cleanup sites may warrant adjustments. Complex-wide, since 1995, states have modified compliance agreements hundreds of times to make appropriate changes based on new information.

Understanding whether and how DOE EM will meet its compliance requirements and how it will respond if it cannot, is a crucial element of state oversight. In the absence of longer term plans, it has been difficult for states to predict whether DOE will be able to meet its compliance requirements until it is in jeopardy of missing them. *The FFTF encourages DOE EM to transparently and openly communicate with the states, particularly regarding compliance milestones and longer term planning.*

The Role of Risk in Cleanup Decisions

States have a strong interest in DOE EM achieving its cleanup goals in a timely and efficient manner, thereby reducing the risk to public health and the environment—one of several factors that can influence cleanup decisions. States support setting priorities to balance environmental risk with regulatory obligations and other factors. This approach, known as "risk plus other factors," stems from a consensus report of the 1996 Federal Facilities Environmental Restoration Dialogue Committee. The report was developed with assistance from the Keystone Center in Colorado and known as the "Keystone Report."[33] The committee that prepared the report was made up of federal agency representatives from EPA, DOE and the U.S. Department of Defense (DoD), with representatives of state agencies, local governments, tribal governments and nongovernmental organizations.

State oversight and compliance agreements are risk informed—that is, they consider both risk and other relevant factors. State decision making is not risk-based—a term that implies that risk is the only consideration used to set

[33] U.S. environmental Protection Agency. (1996, April). *Final report of the Federal Facilities Environmental Restoration Dialogue Committee: Consensus principles and recommendations for improving federal facilities cleanup* (Report EPA/540/R-96/013). Retrieved from https://energy.gov/sites/prod/files/2014/03/f8/fferdc.pdf.

priorities. As recognized in the Keystone Report, such decisions, based solely on risk, are both unwise and contrary to law. Moreover, the process of measuring and comparing risks is fraught with technical problems and not well accepted by the public. *The FFTF supports DOE's continued effort to maintain risk-informed decision making, as established in the Keystone Report, that respects the primacy of compliance agreements.*

Natural Resources Damage Assessment

In addition to compliance agreements, states can help ensure that DOE fulfills both its responsible party and trust responsibilities to restore states' natural resources and the ecological and economic services they provide their citizens by conducting natural resources damage assessments (NRDA).

To develop the NRDA, Trustee Council members at each site, including states, tribes, and federal agencies, collect and analyze information to determine the likelihood of the occurrence and extent of harm to natural resources (injury), and then the cost for restoration (damages). Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the public has a right to compensation to restore, replace, or acquire the equivalent of damaged natural resources and associated loss of services from the release of hazardous substances or from the removal and remedial actions taken to respond to a release.[34]

DOE is responsible for injuries to natural resources (for example, land, aquatic species, water, and wildlife) that occur on or near DOE EM sites because of a contaminant release. States help assess the extent of injury to a natural resource and determine appropriate ways to restore that resource and compensate for its damage. The level of cooperation among trustees can vary widely from site to site. Disagreements among the responsible party and trustees about the assessments or even when to begin the assessment phase have led to lawsuits. DOE is both a trustee of and the responsible party for NRDA at weapons complex sites, creating unique challenges for ensuring that assessment and restoration occur. *The FFTF encourages DOE to fulfill its obligations as a responsible party under the NRDA while appropriately engaging in the process as a trustee.*

Risk Plus Other Factors

The following list of "other factors" was developed by the 1996 Federal Facilities Environmental Restoration Dialogue Committee and included in the Keystone Report. The report notes that these factors "warrant consideration in setting environmental cleanup priorities and milestones":

- Cultural, social, and economic factors, including environmental justice considerations.
- Short-term and long-term ecological effects and environmental impacts in general, including damage to natural resources and lost use.
- Making land available for other uses.
- Acceptability of the action to regulators, tribes, and public stakeholders.
- Statutory requirements and legal agreements.
- Life-cycle costs.
- Pragmatic considerations, such as the ability to execute cleanup projects in a given year, and the feasibility of carrying out the activity in relation to other activities at the facility.
- Overall cost and effectiveness of a proposed activity as well as actual and anticipated funding availability.

Excerpted from Federal Facilities Environmental Restoration Dialogue Committee Final Report, page xii.

Managing Waste Safely

Some waste developed at nuclear weapons sites will persist in the environment for hundreds, thousands, or even millions of years. As such, proper transportation and disposal of waste are critical for reducing risks to public health and the environment. Key aspects of that effort include disposal of HLW in a geologic repository, the disposal of TRU waste at WIPP and the safe transportation and disposition of all radioactive wastes.

[34] For more information, see U.S. Department of the Interior. (n.d.). Restoration program. Retrieved from https://www.doi.gov/restoration.

Changes to Federal Waste Management Strategy

The United States is unique among countries with radioactive waste in that it defines much of the waste by its origin rather than by its radiological characteristics (see Appendix C for a more detailed description of U.S. nuclear waste definitions). DOE's radioactive waste management policy, set forth in DOE Order 435.1, Radioactive Waste Management, currently classifies waste by source and method of production (such as high-level liquid waste from plutonium production), certain technical criteria (including overall radioactivity levels) or some combination of those factors.[35] Over many years of environmental cleanup at DOE EM sites, various parties have suggested updating DOE Order 435.1 to provide greater clarity in definitions of nuclear waste, including suggestions to move toward defining waste based on radiological characteristics. States have concerns about making any changes to DOE Order 435.1 because of the potential impact on agreed-upon strategies for disposing of waste from the cleanup sites, as well as possible ripple effects on waste disposition pathways throughout the weapons complex. *The FTF emphasizes that DOE must consult with states to understand potential issues and challenges before adopting any changes to official waste definitions*.

Greater Than Class C Waste Disposal

Greater Than Class C (GTCC) waste is a category of low-level waste (LLW) that contains concentrations of radionuclides that exceed the limits established by the Nuclear Regulatory Commission for Class C LLW. Decisions have not been made on how and where GTCC waste will be disposed of. In accordance with congressional direction, DOE released a final Environmental Impact Statement (EIS) in 2016 that analyzed alternatives for disposal of GTCC waste. The EIS identified the WIPP geologic repository or land disposal at generic commercial facilities as the preferred alternative. In October 2018, DOE announced plans for an environmental assessment to allow disposal of GTCC at the Waste Control Specialists facility in Texas.[36] *The FFTF encourages DOE to make a final decision on a disposal location with the consent of the host state to allow removal of this high-risk waste from cleanup sites*.

Disposal of HLW

A permanent solution for HLW and spent nuclear fuel (SNF) disposal is of great concern for states in which such materials are located. Although Yucca Mountain in Nevada was designated as the United States' national geologic repository for nuclear waste, it is not clear whether the site will ever be available as a repository. *The FFTF supports DOE's effort to develop permanent disposal options that have the consent of the host state to accept HLW as it is available; no specific disposal site or method is supported.*

Disposal of TRU Waste (WIPP, New Mexico)

WIPP is the only licensed deep geologic repository for any type of radioactive waste; as such, it is critical to the states in which such waste is currently stored. Because of several safety-related accidents in February 2014, WIPP was closed to new waste until corrective actions had been taken. WIPP was reopened on Jan. 9, 2017, with generator sites resuming shipments in April 2017. Since its initial opening, WIPP has accepted 12,259 shipments from 13 sites.[37] To enable increased waste shipments and emplacement, construction of a new ventilation system and other critical infrastructure is currently underway. *The FFTF encourages DOE EM to continue at an appropriate pace and sequence for removing TRU waste from sites and transporting it to WIPP and to operate WIPP at the highest level of safety.*

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[35] See U.S. Department of Energy. Order DOE O 435.1. Retrieved from https://energy.gov/sites/prod/files/2016/03/f30/DOEO435-1RadWasteMan.pdf.

[36] For more information, see DOE's information page on the GTCC environmental assessment at https://www.energy.gov/nepa/ea-2082-disposal-greater-class-c-gtcc-low-level-radioactive-waste-and-gtcc-waste-waste-control.

[37] Waste Data System. (2019, April 17). *Waste Isolation Pilot Plant: WIPP status report*. Retrieved from http://www.wipp.energy.gov/general/GenerateWippStatusReport.pdf. Sites from which WIPP has accepted waste include Argonne National Laboratory, Bettis Atomic Power Laboratory, GE Vallecitos Nuclear Center, Hanford, Idaho National Laboratory, Lawrence Livermore National Laboratory, Los Alamos National Laboratory, Nevada Nuclear Security Site, Oak Ridge National Laboratory, Rocky Flats, Sandia National Laboratories and Savannah River Site.

Transportation of Radioactive Waste

DOE EM has a responsibility to design and operate a safe nuclear waste transportation system. States (with local governments) provide emergency response and other services to protect public health and safety and to ensure safe shipment within their borders. DOE EM has generally worked cooperatively with states to plan major waste-transportation efforts. *The FFTF encourages DOE EM to continue its efforts to plan, coordinate and fund transportation activities in full consultation with affected states. The development of the WIPP transportation program, which was a collaborative process between western states and DOE EM, is an appropriate model for the development of a transportation safety program to support shipments to an HLW repository.*

Long-Term Stewardship

Even when DOE EM considers cleanup complete, additional measures will be needed at most major sites to ensure adequate protection of human health and the environment. Few sites will be cleaned to unrestricted use; therefore, additional LTS activities include varying degrees of surveillance, inspection, restrictions on public access and future uses of land and water, maintenance of relevant information, monitoring the migration of residual contamination and the effectiveness of remedies, and responsible long-term care of the site. A reliable LTS program should be implemented at each site, with roles and responsibilities shared appropriately among DOE offices, states and local governments; tribal nations; and other federal agencies as needed. To adequately protect human health and the environment, LTS activities must continue, uninterrupted, for decades or centuries. *The FFTF supports DOE in carrying out its long-term responsibility to fund LTS activities and will work with DOE and others to determine available funding mechanisms to make the certainty of funding commensurate with the certainty of residual risk at sites where LTS is required.*

Improving Communication Between States and DOE EM

States have expressed several concerns regarding communication with DOE EM, including unclear processes for discussing problems and concerns and lack of notification on key issues. DOE EM has noted a few avenues for the states to communicate concerns, including site-specific advisory boards, congressional representatives and local DOE EM site offices. However, as regulators, states question whether these are appropriate forums for discussing issues specific to their sites. *Implementing direct lines of communication and appropriate protocols for elevating issues of concern when necessary is a priority for the FFTF.*

Coordinating Emergency Response Communication Protocols

The collapse of the Purex Tunnel at Hanford on May 8, 2017, resulted in an important discussion at the Hanford site and other sites across the complex about how to appropriately, accurately and efficiently communicate internally with states and DOE EM and externally with the public during and following an emergency event.[38] With the proliferation of smartphones and social media, it is critical that intergovernmental partners and the public have access to correct information and that misinformation is dispelled quickly. Within 10 minutes of the Purex Tunnel collapse, ABC News, Fox News and the Los Angeles Times had information and photos of the collapse; after 20 minutes, the news had gone global. The Hanford website had two million hits within a matter of minutes, there were tens of thousands of posts on Facebook, and the tunnel collapse was among the highest trending stories on Twitter. The response to this incident demonstrates how social media has introduced challenges to providing accurate and accessible information to the public because increased flow of information can lead to widespread inaccuracies. *The FFTF suggests that DOE EM, in coordination with the states and other parties, develop a uniform public communications protocol for emergency situations that recognizes the rapid dissemination of information in the age of social media.*

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[38] Washington Department of Ecology. (n.d.). Updates on PUREX Tunnels at Hanford. Retrieved from https://ecology.wa.gov/Waste-Toxics/Nuclear-waste/Hanford-cleanup/PUREX.

Building 305-A and Building 777-10A, Savannah River Site, South Carolina. Both buildings were used to test components and aid development and testing for reactor design. Photo courtesy of Library of Congress, Prints & Photographs Division, HAER, Reproduction number HAER SC-43-1

State by State Overview

This section provides an overview of DOE nuclear weapons sites located in the states that participate in the NGA Solutions: Center for Best Practices Federal Facilities Task Force (FFTF). Each section contains background information about the tasks each site performed and the types of waste it generates as well as any specific waste disposal functions, cleanup accomplishments, current site-specific issues and the site's relationship to other sites in the nuclear weapons complex. The accomplishments discussed here are distinct from the major complex-wide successes that the report covers.

- **IDAHO:** Idaho National Laboratory
- **KENTUCKY:** Paducah Gaseous Diffusion Plant
- **MISSOURI:** Kansas City Plant, Weldon Spring
- **NEVADA:** Nevada National Security Site (NNSS)
- **NEW MEXICO:** Los Alamos National Laboratory, Sandia National Laboratories, WIPP
- **NEW YORK:** West Valley Demonstration Project
- **OHIO:** Portsmouth, Mound, Fernald
- **SOUTH CAROLINA:** Savannah River Site (SRS)
- **TENNESSEE:** Oak Ridge Reservation
- **TEXAS:** Pantex
- **WASHINGTON and OREGON:** Hanford Site

IDAHO

Idaho National Laboratory

Background

The Idaho National Laboratory, located in southeastern Idaho and with additional research and support facilities in Idaho Falls, was established in 1949 as the National Reactor Testing Station.[39] For many years, Idaho National Laboratory housed the largest concentration of nuclear reactors in the world.[40] In total, 52 reactors were built at Idaho National Laboratory, including the U.S. Navy's first prototype nuclear propulsion plant.[41] Four agreements form the regulatory framework at the Idaho National Laboratory: the Federal Facilities Agreement Consent Order, which mandates milestones for cleanup under the Comprehensive Environmental Response, Compensation, and Liability Act; the Site Treatment Plan; the Notice of Noncompliance Consent Order, which governs certain waste management activities; and the 1995 Settlement Agreement, which settled a lawsuit between the state of Idaho, the Navy and the U.S. Department of Energy (DOE) and requires that certain waste be removed from Idaho by specific dates.[42]

FIGURE 8: Demolition of CPP 601-602 at the Idaho site. Photo courtesy of U.S. Department of Energy.

Major Accomplishments

DOE EM has worked with Idaho to achieve the following outcomes:

- The Advanced Mixed Waste Treatment Project (AMWTP) continues to successfully treat transuranic (TRU) waste from Idaho and other states.
- DOE EM completed transuranic waste retrieval activities at the Advanced Mixed Waste Treatment Project's Transuranic Storage Area-Retrieval Enclosure (TSA RE). The waste was received at the Idaho National Laboratory site after 1970 in drums, boxes and cargo containers; placed on asphalt pads; and then covered with an earthen berm. In the 1990s, a large building was constructed over the seven-acre berm. Beginning in 2003, the function of the enclosure has been to retrieve the approximately 50,000 cubic meters (m^3) of waste in the TSA RE and to characterize, sort, treat and ship the waste to its final disposal sites, primarily to New Mexico's Waste Isolation Pilot Plant (WIPP). The last waste container was retrieved in 2017. Recently retrieved waste now awaits treatment at the Advanced Mixed Waste Treatment Project.[43]

[39] U.S. Department of Energy. (n.d.). Brief history of the Idaho National Laboratory (INL). Retrieved from https://www.id.energy.gov/insideNEID/BriefHistory.htm.
[40] Public tours offer insight into Idaho National Laboratory. (2011, June 10). Idaho State Journal. Retrieved from https://www.idahostatejournal.com/news/online/public-tours-offer-insight-into-idaho-national-laboratory/article_960e3196-9332-11e0-a7d0-001cc4c03286.html.
[41] U.S. Department of Energy. (n.d.). Brief history of the Idaho National Laboratory (INL). Retrieved from https://www.id.energy.gov/insideNEID/BriefHistory.htm.
[42] U.S. Department of Energy. (n.d.). Commitments and agreements. Retrieved from https://www.id.energy.gov/insideneid/commitme.htm.
[43] U.S. Department of Energy. (2017, March 15). Transuranic waste retrieval at Idaho's AMWTP now complete. Retrieved from https://www.energy.gov/em/articles/transuranic-waste-retrieval-idaho-s-amwtp-now-complete.

- DOE EM excavated and repackaged solvent, transuranic waste, contaminated graphite and filter media waste for eventual shipment to WIPP in New Mexico from approximately 85 percent of the required acres at the Subsurface Disposal Area.[44]
- DOE EM treated and repackaged approximately 10,494 sludge drums for disposal at WIPP.
- DOE EM treated and shipped 124 m^3 of remotely handled transuranic waste for disposal at WIPP.
- DOE EM transferred more than 104 metric tons of heavy metal from spent nuclear fuel (SNF) from wet storage facilities to dry storage.

Site-Specific Issues

Leading challenges at Idaho National Laboratory include meeting the obligations of the 1995 Settlement Agreement and other legal agreements between DOE and the state. Among other things, the agreements require disposal of transuranic waste outside of Idaho, retrieval from the bin sets and treatment of high-level waste (HLW) calcine generated from SNF reprocessing conducted decades ago, and treatment of liquid HLW (including sodium-bearing waste) stored in tanks above the Snake River Plain Aquifer, a critical drinking water and agricultural resource for much of southern Idaho. DOE EM has completed construction of the Integrated Waste Treatment Unit to treat the liquid HLW, but delays during testing have prevented DOE EM from meeting deadlines to achieve full facility operation.[45]

Relationship to Other Sites in the Complex

Idaho National Laboratory's relationships with other DOE sites are critical to completing the requirements of the 1995 Settlement Agreement, including WIPP for disposal of TRU waste. In addition to HLW and SNF stored and generated on-site, Idaho National Laboratory stores the damaged reactor from Three Mile Island and SNF from Navy vessels and foreign research reactors. Disposal of HLW and SNF from Idaho National Laboratory depends on future decisions about permanent geologic disposal. The Idaho National Laboratory plays a key role in treating mixed low-level waste (LLW) and TRU waste from around the complex.

LLW and mixed LLW cleanup at Idaho National Laboratory depends heavily on both the Nevada National Security Site (NNSS) and commercial sites around the country providing an avenue for the ultimate disposal of legacy waste. According to DOE EM estimates, more than 35,000 m^3 of LLW and 3,500 m^3 of mixed LLW will be sent from Idaho to the NNSS for disposal between 2018 and 2050.[46]

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[44] U.S. Department of Energy. (2018, August 12). *Third buried waste retrieval project underway at DOE Idaho site* [Press release]. Retrieved from https://www.id.energy.gov/news/PressReleases/PR081218.htm.

[45] Exchange Monitor. (2018, August 29). Idaho waste treatment unit startup unlikely in 2018, DNFSB suggests. Retrieved from https://www.exchangemonitor.com/idaho-waste-treatment-unit-startup-seems-unlikely-2018-dnfsb-suggests/.

[46] Applied Research Center, Florida International University. (n.d.). Welcome to WIMS: Waste Information Management System. Retrieved from http://www.emwims.org.

KENTUCKY

Paducah Gaseous Diffusion Plant

Background

The Paducah Gaseous Diffusion Plant is in rural western Kentucky, 10 miles west of Paducah (Figures 9 and 10). For more than 60 years, the Paducah Gaseous Diffusion Plant enriched uranium, first supporting the nation's nuclear weapons program and then producing fuel for commercial nuclear power plants. Paducah Gaseous Diffusion Plant enrichment operations ended in 2013, and the facility transitioned to US. Department of Energy Office of Environmental Management (DOE EM) in 2014.[47]

FIGURE 9: Aerial view of Paducah Gaseous Diffusion Plant. Photo courtesy of state of Kentucky.

Cleanup at the site is driven by the 1998 Federal Facilities Agreement (FFA) between DOE, U.S. Environmental Protection Agency (EPA) Region 4 and the Kentucky Energy and Environment Cabinet. The parties to the FFA are currently discussing the Site Management Plan to incorporate decontamination and demolition of the gaseous diffusion plant and investigation of areas deemed inaccessible when the plant was in operation.[48]

Major Accomplishments

DOE EM has worked with Kentucky to achieve the following outcomes:

- Two pump-and-treat systems have been in operation for two decades and have collectively treated more than 4 billion gallons of groundwater.[49] Approximately 7,800 gallons of trichloroethylene, a common industrial degreaser, and other volatile organic compounds have been removed by treating groundwater in the dissolved phase plume through the pump-and-treat technology and by remediating accessible source areas (spill and leak sites).[50]

[47] U.S. Department of Energy, Portsmouth/Paducah Project Office. (n.d.). Paducah site. Retrieved from https://www.energy.gov/pppo/paducah-site.
[48] Kentucky Energy and Environment Cabinet. (2019). Paducah Gaseous Diffusion Plant (PGDP). Retrieved from https://eec.ky.gov/Environmental-Protection/Waste/hazardous-waste/Pages/paducah-gaseous-diffusion-plant.aspx.
[49] U.S. Department of Energy, Office of Environmental Management. (2018, January 9). Paducah site develops "end game" strategy for groundwater contamination, Retrieved from https://www.energy.gov/em/articles/paducah-site-develops-end-game-strategy-groundwater-contamination.
[50] U.S Department of Energy, Office of Environmental Management. (2018, June). Paducah site cleanup by the numbers. Retrieved from https://www.energy.gov/sites/prod/files/2018/10/f56/Paducah-Site-by-Numbers-June-2018A.pdf.

- Depleted uranium hexafluoride (DUF6) conversion facilities were built at Paducah, Kentucky, and Portsmouth, Ohio, to convert an estimated 750,000 metric tons of DOE's surplus DUF6 inventory into a more stable chemical form.[51] Approximately 62,000 metric tons have been processed, with an estimated 30 years of operations to complete the remaining inventory (at the facility's process design rate).[52]
- In total, 84 inactive facilities successfully underwent deactivation and demolition as of June 2018.[53] More than 400,000 square feet have been demolished.
- In total, 33,000 tons of contaminated metal,[54] 420,000 cubic feet (ft^3) of legacy waste[55] and 866,000 ft^3 of DOE material storage areas have been disposed of.

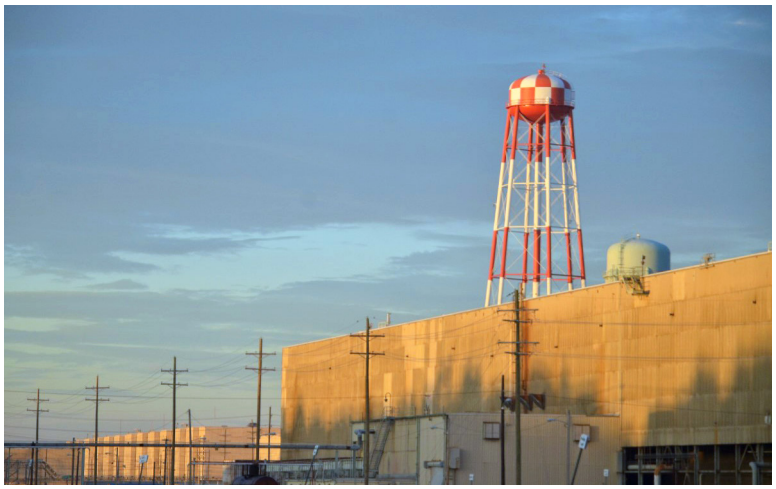

FIGURE 10: Paducah Gaseous Diffusion Plant. Photo courtesy of state of Kentucky.

Site-Specific Issues

In August 2017, DOE, EPA Region 4 and the Kentucky Department for Environmental Protection signed a memorandum of agreement to resequence all the environmental remediation work at the Paducah site to concentrate first on the C-400 building, which is the main source of the two 4-mile-long trichloroethylene groundwater contamination plumes. The C-400 building is scheduled to start demolition to slab in late 2018.[56] The demolition will be followed by a comprehensive investigation beneath and around the building to define all sources of contamination and determine how each contaminant is distributed vertically and laterally. All remaining environmental projects, except the area directly north of the C-720 "Machine Shop" building (referred to as "SWMU 211A"), will be moved out into the future.

Since DOE EM resumed control of the Paducah Gaseous Diffusion Plant in October 2014, resources are being realigned to support deactivation and demolition activities. More than 500 structures/systems will eventually undergo deactivation and demolition. The estimated volume of waste material that requires disposal from deactivation and demolition operations is about 3.6 million cubic yards.[57] As deactivation and demolition operations progress, it is anticipated that opportunities will arise to address contamination previously considered inaccessible (underneath buildings and infrastructure).

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[51] U.S. Department of Energy, Portsmouth/Paducah Project Office. (n.d.). DUF6 Conversion Project. Retrieved from https://www.energy.gov/pppo/pppo-services/pppo-cleanup-projects-portsmouth-paducah-duf6/duf6-conversion-project.

[52] U.S. Department of Energy, Office of Environmental Management. (2019, January 22). DUF6 Conversion Project off to strong start following improvements. Retrieved from https://www.energy.gov/em/articles/duf6-conversion-project-strong-start-following-improvements.

[53] U.S Department of Energy, Office of Environmental Management. (2018, June). Paducah site cleanup by the numbers. Retrieved from https://www.energy.gov/sites/prod/files/2018/10/f56/Paducah-Site-by-Numbers-June-2018A.pdf.

[54] U.S. Department of Energy, Office of Environmental Management. (2017, March 9) Portsmouth/Paducah Project Office: Waste Management Symposia, Phoenix, Arizona. Retrieved from http://archive.wmsym.org/2017/presentations/PowerPointFile_75_0307163206.pdf.

[55] U.S. Department of Energy, Office of Environmental Management. (2017, March 9) Portsmouth/Paducah Project Office: Waste Management Symposia, Phoenix, Arizona. Retrieved from http://archive.wmsym.org/2017/presentations/PowerPointFile_75_0307163206.pdf.

[56] U.S. Department of Energy, Office of Environmental Management. (2018, January 9). Paducah site develops "end game" strategy for groundwater contamination. Retrieved from https://www.energy.gov/em/articles/paducah-site-develops-end-game-strategy-groundwater-contamination.

[57] UU.S. Department of Energy, Office of Environmental management. (n.d.). DOE Paducah site tour. Retrieved from https://www.emcbc.doe.gov/SEB/PGDP%20Deactivation/Documents/Site%20Tours/DOE%20Paducah%20Site%20Tour-Deactivation%20Task%20Order.pdf.

Relationships to Other Sites in the Complex

- Portsmouth, Ohio, and Oak Ridge, Tennessee, also had gaseous diffusion plants in various stages of deactivation and demolition.[58]
- Portsmouth also has a DUF6 conversion facility.[59]
- Paducah has shipped waste to the Nevada National Security Site.[60]

[58] U.S. Department of Energy, Oak Ridge Office of Environmental Management. (2016, August 30). DOE completes decade-long project at Oak Ridge gaseous diffusion complex. Retrieved from https://www.energy.gov/orem/articles/doe-completes-decade-long-project-oak-ridge-gaseous-diffusion-complex.

[59] U.S. Department of Energy, Portsmouth/Paducah Project Office. (n.d.). PPPO cleanup projects—Portsmouth, Paducah, & DUF6. Retrieved from https://www.energy.gov/pppo/pppo-services/pppo-cleanup-projects-portsmouth-paducah-duf6.

[60] U.S. Department of Energy. (2019, January 31). Energy Department statement on plutonium shipments to Nevada. Retrieved from https://www.energy.gov/articles/energy-department-statement-plutonium-shipments-nevada.

MISSOURI

Kansas City Plant, Weldon Spring Site

Background

Missouri is home to one former site, the Kansas City Plant, and one long-term stewardship (LTS) site, the Weldon Spring Site. The state also hosts the current U.S. Department of Energy (DOE)-National Nuclear Security Administration (NNSA) Kansas City National Security Campus.

The former Kansas City Plant occupied 136 acres of the 309-acre Bannister Federal Complex in Kansas City, Missouri. The Kansas City Plant's mission—to manufacture nonnuclear components for defense purposes—ended in August 2014, and the facility was relocated to the new Kansas City National Security Campus in south Kansas City.[61] U.S. Navy and DOE-NNSA operations at the Bannister Federal Complex released hazardous materials, primarily chlorinated solvents and polychlorinated biphenyls, into the environment.[62] DOE-NNSA identified historic radioactive contamination and characterized and remediated it to an unrestricted release. DOE-NNSA developed a request for early transfer and, following the governor's approval, transferred the entire Kansas City Plant and the portion of the Bannister Federal Complex west of the railroad tracks to Bannister Transformation & Development LLC on Nov. 15, 2017.[63] Bannister Transformation & Development has now assumed the responsibility for completing corrective action and site remediation under the Resource Conservation and Recovery Act (RCRA), while DOE is responsible financially for the cost of site remediation and for long term stewardship, maintenance and operations of remedial actions.

DOE's new Kansas City National Security Campus facility continues the mission of the Kansas City Plant, manufacturing non-nuclear components for defense purposes. The facility was designed to prevent accidental releases of contaminants to the environment. Many of the same materials that were used at the Kansas City Plant continue to be used at the new facility.

FIGURE 11: Kansas City National Security Campus. Photo courtesy of U.S. Department of Energy.

DOE's Office of Legacy Management (LM) currently manages the Weldon Spring Site as an LTS site. Located 30 miles west of St. Louis, the site served a variety of missions for the U.S. Army and DOE's parent agencies (the U.S. Atomic Energy Commission and others) from 1941 to 1984 that involved both explosive ordnance and

[61] U.S. Department of Energy, National Nuclear Security Administration. (2013, February). *Draft environmental assessment for the transfer of the Kansas City Plant, Kansas City, Missouri.* Retrieved from https://www.energy.gov/sites/prod/files/EA-1947-DEA-2013.pdf.
[62] Missouri Department of Natural Resources. (n.d.). Bannister Federal Complex. Retrieved from https://dnr.mo.gov/env/hwp/fedfac/bfc.htm.
[63] Missouri Department of Natural Resources. (n.d.). Bannister Federal Complex. Retrieved from https://dnr.mo.gov/env/hwp/fedfac/bfc.htm.

nuclear materials. The DOE portion of the operations, listed on the National Priority List in 1987, was a plant that converted processed uranium ore concentrates to pure uranium trioxide and other products.[64]

Two other sites in the St. Louis area of Missouri are currently being cleaned up by the U.S. Army Corp of Engineers under the Formerly Utilized Sites Remedial Action Program.[65] Once these sites have been remediated, they will be transitioned back to DOE LM for long term stewardship.

Major Accomplishments

DOE has worked with Missouri to achieve the following outcomes:

- At the Kansas City Plant, DOE carried out environmental restoration activities at 43 release sites or areas of concern that posed a potential threat to human health and the environment. Operational oversight was accomplished through an Agreement in Principle,[66] which allows for a day-to-day state presence at the site, enabling the state to serve as an independent party that can assist in answering the public's questions about the operation without causing security concerns. Agreement in Principle personnel currently have non-regulatory oversite of radiologic, beryllium, asbestos, lead paint vapor intrusion and off-site contamination such as polychlorinated biphenyls. In 2014, the RCRA post-closure permit for the Kansas City Plant was expanded to include the entire Bannister Federal Complex, which the U.S. General Services Administration and DOE-NNSA jointly owned and managed prior to the transfer of the 235 acres west of the railroad tracks. DOE-NNSA, with state concurrence, transferred the entire Kansas City Plant to Bannister Transformation & Development LLC on Nov. 15, 2017.
- Cleanup at Weldon Spring began in 1984 and continued in phases until the completion in 2001 of a 45-acre disposal cell in an area formerly occupied by chemical plant production buildings. The disposal cell contains approximately 1.48 million cubic yards of contaminated materials.[67] Leachate from the disposal cell is collected, treated and discharged off-site. A native prairie has been established around the disposal cell that provides erosion control and educational opportunities through a viewing platform at the peak of the disposal cell. The site also offers public trails and an interpretive center that preserves the site's history.

Site-Specific Issues

At the Weldon Spring Site, a long-term surveillance plan details a groundwater monitoring program, a sitewide inspection process and institutional controls that must be maintained in perpetuity.[68] The presence of residual contamination requires institutional and engineering controls that must be inspected regularly and maintained. Now that the site has been in LTS for an extended period, the state has noted some ongoing concerns regarding assumptions made in early assessment documents compared with actual site conditions that DOE must address.

As the Kansas City National Security Campus continues the former Kansas City Plant's ongoing mission of manufacturing nonnuclear components of nuclear weapons, the need for an on-site Agreement in Principle remains. The public continues to voice concerns regarding the activities at the Kansas City National Security Campus, and an impartial

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[64] U.S. Environmental Protection Agency. (1984, October 15). Amendment to National Oil and Hazardous Substances Contingency Plan: The National Priorities List. Federal Register Notice, 49(200). Retrieved from https://semspub.epa.gov/work/HQ/189641.pdf; U.S. Environmental Protection Agency. (1987, July 22). National Priorities List for Uncontrolled Hazardous Waste Sites. Federal Register Notice, 52(140). Retrieved from https://semspub.epa.gov/work/HQ/189629.pdf.

[65] Missouri Department of Natural Resources. (n.d.). Formerly Utilized Sites Remedial Action Program (FUSRAP). Retrieved from https://dnr.mo.gov/env/hwp/fedfac/fusrap/index.html.

[66] U.S. Department of Energy. (2013, October). Record of categorical exclusion (CX) determination. Retrieved from https://kcnsc.doe.gov/docs/default-source/cx-determinations/nepa-mdnr-aip.pdf?sfvrsn=b628f49f_2.

[67] U.S. Department of Energy, Office of Legacy Management. (2011, September). *Weldon Spring site fourth five-year review* (Report No. LMS/WEL/S07406). Retrieved from https://www.lm.doe.gov/Weldon/Fourth_Five-Year_Review.pdf.

[68] U.S. Department of Energy, Office of Legacy Management. (2011, September). *Weldon Spring site fourth five-year review* (Report No. LMS/WEL/S07406). Retrieved from https://www.lm.doe.gov/Weldon/Fourth_Five-Year_Review.pdf.

independent Agreement in Principle staff person familiar with the facility would help address these concerns regarding DOE's activities at the site.

Relationship to Other Sites in the Complex

The Kansas City Plant previously provided all the nonnuclear components for the nuclear complex's weaponry. As a result, although the Kansas City Plant/Bannister Federal Complex site was transferred to a private entity through the early transfer process, NNSA will continue its mission at the Kansas City National Security Campus.

Weldon Spring was one of the first sites to be remediated and transferred to DOE LM. As more sites begin to transition from active DOE EM work to remediation to long term stewardship, Weldon Spring has served as a guide for how to consider and address the long-term issues at a site even before a remedy has been chosen. It has also showcased how including an on-site information source through an interpretive center helps educate current and future generations about what occurred at the site.[69]

[69] State and Tribal Government Working Group, National Conference of State Legislatures. (2017). *Closure for the seventh generation: A report from the State and Tribal Government Working Group's Long-Term Stewardship Committee*. 2017 edition. Retrieved from https://www.energy.gov/sites/prod/files/2018/07/f53/STGWG_Closure_for_7th_Gen_Report_%282017%29.pdf.

NEVADA

Nevada National Security Site

Background

The Nevada National Security Site (NNSS)—formerly known as the Nevada Test Site—occupies approximately 1,350 square miles in southeastern Nye County, about 65 miles northwest of Las Vegas (Figure 12). The NNSS is larger than Rhode Island and comprises more than 40 percent of all U.S. Department of Energy (DOE) land holdings.[70] As a DOE defense program site, the primary mission of the NNSS is to help ensure the security of the United States and its allies by supporting the stewardship of the nuclear deterrent, providing emergency response capability, and training and contributing to key nonproliferation and arms control initiatives. The site also has a role in National Nuclear Security Administration nuclear nonproliferation programs, nuclear emergency response capabilities and other federal projects.[71]

FIGURE 12: Nevada National Security Site Revegetation Efforts. Photo courtesy of U.S. Department of Energy.

Several regulatory agreements currently guide cleanup and disposal activities at the site. A 1999 Agreement in Principle identified activities that Nevada and DOE would undertake to work cooperatively to assure citizens of Nevada that the public's health and safety as well as the environment are protected. The Agreement in Principle and its later revisions afford Nevada the opportunity to provide input into the evaluation of the waste sent to the NNSS for disposal.[72] Nevada also engages with DOE EM on the review of low-level waste (LLW) transportation protocols and notifications, emergency planning and response exercises.[73]

The 1996 Federal Facility Agreement and Consent Order (FFACO) governs remediation of historical contamination and stipulates a process to ensure that DOE and the U.S. Department of Defense thoroughly investigate and complete corrective actions for contaminated sites on the NNSS and the nearby Nevada Test and Training Range. The NNSS also has an Resource Conservation and Recovery Act Part B permit that includes authorization to dispose of mixed LLW generated at the NNSS and other DOE EM sites. The permit, which was modified in 2018 to add a second mixed LLW cell, is effective until December 2020.[74]

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[70] Nevada National Security Site. (n.d.). About the NNSS. Retrieved from https://www.nnss.gov/pages/about.html.
[71] Nevada National Security Site. (n.d.). About the NNSS. Retrieved from https://www.nnss.gov/pages/about.html.
[72] Nevada Division of Environmental Protection. (n.d.). Agreement in principle (AIP). Retrieved from https://ndep.nv.gov/land/department-of-energy-oversight/agreement-in-principle-aip.
[73] National Nuclear Security Administration. (2016, November). *Nevada National Security Site waste acceptance criteria* (Report No. DOE/NV—325-16-00). Retrieved from https://www.nnss.gov/docs/docs_RWM/NNSSWAC_Nov%202016.pdf.
[74] Nevada National Security Site. (2018, September). *Environmental report 2017*. Retrieved from http://www.nnss.gov/docs/docs_LibraryPublications/2017%20NNSSER.pdf.

Major Accomplishments

Since the FFACO was signed in 1996, DOE EM has made significant progress in addressing the remediation process in several categories of contaminated sites:

- Industrial site restoration addresses facility deactivation and demolition; historical infrastructure remediation efforts; and conventional weapons cleanup, including unexploded ordnance. The FFACO identified more than 2,000 such sites; to date, all but 12 sites have been clean-closed or closed in place, meeting specific protective closure criteria that enable DOE to close the site with use restrictions.[75]
- At the underground test areas, where underground nuclear tests contaminated groundwater, Nevada approved the closure of one corrective action unit, Frenchman Flat, moving it into long-term monitoring. Nevada and DOE formally established use restrictions, regulatory boundaries and a long-term monitoring strategy. This unit is the first of five to move to the closure stage since the FFACO was signed in 1996. Two other underground test areas are expected to be approved for advancement to the closure stage in the 2020 timeframe.[76]
- Soil sites contain contamination from historical nuclear detonations, safety experiments, nuclear reactor development, nuclear rocket development and hydronuclear experiments. To date, 136 soil sites have either been clean-closed or closed in place with monitoring and use restrictions through a process to which the state and DOE have agreed.[77] The remaining seven soil sites should be clean-closed or closed in place in 2019.
- The two Nevada off-site areas — Project Shoal and the Central Nevada Test Area (CNTA) — were transferred to the DOE Office of Legacy Management (DOE LM) in 2006. The surface unit at Project Shoal was clean-closed and has no monitoring requirements. Postclosure monitoring is required for the CNTA surface unit. Nevada approved the groundwater unit at the CNTA moving into the closure stage in 2015; therefore, it is currently in long-term monitoring.[78] Nevada and DOE LM are completing the characterization of the groundwater unit at Project Shoal. It is expected that the groundwater unit will be approved to move into the closure stage in the 2020 timeframe.

Site-Specific Issues

Although the NNSS has a relatively small DOE EM cleanup budget (approximately $65 million in 2015, or just over 1 percent of all DOE cleanup funds), the site contains significant contamination in surface soils and groundwater. Contamination of groundwater is an area of focus for the state of Nevada at both the NNSS and the Nevada off-site locations; nearly 30 percent of more than 828 underground nuclear tests conducted at the site were performed near groundwater.[79] Nevada will continue to establish regulatory boundaries for each groundwater unit based on model-generated contaminant boundaries or potential flow paths. If radionuclide levels ever exceed established levels at those boundaries, Nevada will require DOE EM to submit a plan to meet specific groundwater unit objectives.

Nevada has identified the following priorities associated with low-level radioactive waste management at the NNSS and is working with DOE EM and other partners across the complex on these matters:

1. Waste disposal predictability and forecasting.
2. Appropriate waste classification and management based on actual waste characteristics rather than origin.
3. Enhanced waste verification.
4. Ongoing potential incident planning and outreach to local stakeholders.

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[75] Nevada National Security Site. (2018, September). *Environmental report 2017*. Retrieved from http://www.nnss.gov/docs/docs_LibraryPublications/2017%20NNSSER.pdf.
[76] Nevada National Security Site. (2018, September). *Environmental report 2017*. Retrieved from http://www.nnss.gov/docs/docs_LibraryPublications/2017%20NNSSER.pdf.
[77] Andres, C. (2018, July 24). Federal Facility Agreement and Consent Order (FFACO) quarterly report [Memorandum]. Retrieved from https://ndep.nv.gov/uploads/land-doe-ffaco-docs/2018_4th_Qtr_FFACO_AIP.pdf.
[78] Andres, C. (2018, July 24). Federal Facility Agreement and Consent Order (FFACO) quarterly report [Memorandum]. Retrieved from https://ndep.nv.gov/uploads/land-doe-ffaco-docs/2018_4th_Qtr_FFACO_AIP.pdf.
[79] Nevada National Security Site. (n.d.). Groundwater characterization. Retrieved from https://www.nnss.gov/pages/programs/em/GroundwaterCharacterization.html.

Relationship to Other Sites in the Complex

The NNSS is currently the only DOE-owned disposal site DOE has identified for off-site disposal of DOE-generated low-level, mixed low-level and classified waste. DOE designated the NNSS and Hanford as the two regional disposal sites for off-site LLW and mixed LLW from throughout the complex in 2000; however, a moratorium is in place on most new waste shipments to Hanford until the Waste Treatment Plant is in full operation.[80] NNSS receipt of waste is conducted in accordance with the facility waste acceptance criteria and a waste profile review process that includes state review.

Nevada and DOE have agreed to engage in discussions on any potential future changes to the NNSS Waste Acceptance Criteria or LLW classification in general.[81]

The NNSS will continue to generate LLW into the future. DOE will manage and dispose of the vast majority of waste on-site, with the exception of a small quantity of transuranic waste generated and currently stored at the site that will ultimately be shipped to the Waste Isolation Pilot Plant in New Mexico.

[80] U.S. Department of Energy. (n.d.). *Hanford annual site environmental report for calendar year 2017*. Retrieved from https://msa.hanford.gov/files.cfm/DOE-RL-2018-32_Rev0_UPDATED.pdf.

[81] National Nuclear Security Administration. (2016, November). *Nevada National Security Site waste acceptance criteria* (Report No. DOE/NV—325-16-00). Retrieved from https://www.nnss.gov/docs/docs_RWM/NNSSWAC_Nov%202016.pdf.

NEW MEXICO

Los Alamos National Laboratory, Sandia National Laboratories, the Waste Isolation Pilot Plant

Background

New Mexico hosts three major U.S. Department of Energy (DOE) sites: Los Alamos National Laboratory, Sandia National Laboratories and the Waste Isolation Pilot Plant (WIPP).

FIGURE 13: TRU waste shipment to WIPP. Photo courtesy of U.S. Department of Energy.

Los Alamos National Laboratory, located 25 miles northwest of Santa Fe, was established in 1942 to develop the first atomic bomb. It still serves as a key center for weapons and basic science research. The site spans more than 40 square miles and is dissected by canyons several hundred feet deep that drain into the Rio Grande River. The regional aquifer beneath the plateau is the sole water supply for the laboratory and the communities of Los Alamos and White Rock.[82]

Sandia National Laboratories began operating in 1945 on Sandia Base in Albuquerque to support Los Alamos National Laboratory's efforts to build the first atomic bomb. Sandia National Laboratories is located within Kirtland Air Force Base and shares its northern boundary with the city of Albuquerque. The regional aquifer in the Albuquerque Basin serves the nearly 1 million people who live in Albuquerque and its surrounding communities. Like Los Alamos National Laboratory, Sandia National Laboratories has contributed to groundwater contamination of its regional aquifer, with at least four groundwater plumes identified.[83]

WIPP, located 26 miles east of Carlsbad, was authorized by Congress in 1979 as the nation's first (and remains the only) underground repository for the permanent disposal of the nation's defense-related transuranic waste (Figure 13).[84] WIPP is operated under a repository certification from the U.S. Environmental Protection Agency and a hazardous waste facility permit issued by the New Mexico Environment Department. The latter document requires that DOE EM use robust characterization procedures at each generator site across the complex before WIPP can receive waste.[85] DOE EM requires strict compliance with the waste analysis plan and waste acceptance criteria in the WIPP permit.

[82] Los Alamos National Laboratory. (n.d.). Our history. Retrieved from https://www.lanl.gov/about/history-innovation/.
[83] Sandia National Laboratories. (2019). History. Retrieved from https://www.sandia.gov/about/history/index.html.
[84] Waste Isolation Pilot Plant. (n.d.). History. Retrieved from https://wipp.energy.gov/historytimeline.asp.
[85] New Mexico Environment Department. Hazardous Waste Bureau: WIPP. Retrieved from https://www.env.nm.gov/hazardous-waste/wipp/.

Major Accomplishments

In New Mexico, WIPP, Los Alamos National Laboratory and Sandia National Laboratories have all had recent successes:

- **WIPP/Los Alamos National Laboratory:** In January 2016, the New Mexico Environment Department and DOE signed a settlement agreement and stipulated final order to address the 2014 events. They agreed to:
  – An enhanced waste characterization review and process.
  – Enhanced facility maintenance and site emergency response.
  – Funding of various supplemental environmental projects.
- **WIPP Reopening and More Stringent Reviews:** After being shut down for almost three years following the radiation leak of 2014, the New Mexico Environment Department, under the leadership of Gov. Susana Martinez, held a facility-wide inspection in late 2016 to clear the way for WIPP to resume operations. Part of this inspection was to verify that the enhanced facility emergency response processes and training and the more stringent reviews for waste coming to WIPP required by the settlement agreement and stipulated final order were being implemented.[86] WIPP reopened on Jan. 9, 2017, and has received more than 7,000 containers in over 300 shipments since reopening. DOE EM is currently reviewing options for properly storing more than 400 containers of problematic Los Alamos National Laboratory waste. In addition, DOE EM has submitted several permit modifications for WIPP. The first is a Volume of Record modification that would potentially add 30 percent more storage capacity to the plant.[87]
- **Supplemental Environmental Projects at WIPP and Los Alamos National Laboratory:** The settlement agreement and stipulated final order included the completion of supplemental environmental projects for both the Los Alamos National Laboratory and WIPP.[88] Funding was provided for WIPP for the following projects: road repairs along the WIPP transportation route in southern New Mexico; triennial independent reviews of environmental regulatory compliance and operations at WIPP (the first of which has already been completed); enhanced training for local emergency responders; and the creation of a state-of-the art emergency operations center in Carlsbad, New Mexico. Projects at the Los Alamos National Laboratory include potable waterline upgrades, watershed enhancement, storm water monitoring, independent reviews of environment regulatory compliance and operations at Los Alamos National Laboratory, and road projects in the Los Alamos area.
- **Los Alamos National Laboratory Chromium Plume Cleanup:** The New Mexico Environment Department and DOE EM are partnering on the chromium plume cleanup at Los Alamos National Laboratory as part of the settlement agreement signed in 2016.[89] For federal fiscal year 2017, DOE EM completed 15 of the 16 milestones on time;[90] one received an extension by the New Mexico Environment Department because additional characterization of a contaminated water plume was needed.[91] For federal fiscal year 2018, 15 milestones were agreed upon.[92] Extension requests were accepted for one or two milestones because additional work is needed to proceed with the projects. The New Mexico Environment Department and DOE EM are in the annual planning process for federal fiscal year 2019, and 19 milestones have been proposed. DOE EM has successfully completed treatment of all remediated and unremediated nitrate salt-bearing waste

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[86] U.S. Department of Energy, Carlsbad Field Office. (2016, June 3). *Class 2 permit modification request. Revise the RCRA Contingency Plan and associated emergency response personnel training and active room ventilation flow rate: Waste Isolation Pilot Plant, Carlsbad, New Mexico* (WIPP Permit No. NM4890139088-TSDF). Retrieved from https://www.env.nm.gov/wipp/documents/160603.pdf.

[87] U.S. Department of Energy, Carlsbad Field Office. (2017, December). *Environmental assessment for the above ground storage capacity at the Waste Isolation Pilot Plant* (Report No. DOE/EA-2064). Retrieved from http://www.sric.org/nuclear/docs/EA_AGSC.pdf.

[88] U.S. Department of Energy. (2016, January 22). *U.S. Department of Energy and New Mexico finalize $74M in settlement agreements for nuclear waste incidents of 2014*. Retrieved from https://www.energy.gov/articles/us-department-energy-and-new-mexico-finalize-74m-settlement-agreements-nuclear-waste.

[89] New Mexico Environment Department. (2016, January 22). *Settlement agreement and stipulated final order*. Retrieved from https://www.env.nm.gov/OOTS/documents/LANLSASFO-FINAL1_22_16.pdf.

[90] New Mexico Environment Department. (2016, June). *Appendix B: Milestones and targets*. Retrieved from https://www.env.nm.gov/wp-content/uploads/2016/05/Appendix-B-Milestones-and-Targets-June-2016.pdf.

[91] New Mexico Environment Department. (2017, December 4). *Fiscal year 2017 deliverables accomplishments and fiscal year 2018 deliverables list*. Retrieved from https://www.env.nm.gov/wp-content/uploads/2016/05/38291.pdf.

[92] New Mexico Environment Department. (2018). *Appendix B: Milestones and targets*. Retrieved from https://www.env.nm.gov/wp-content/uploads/2016/05/LANL-CO-APPENDIX-B-2018.pdf.

stored at Los Alamos National Laboratory, which was similar to the waste that caused the 2014 incident at WIPP that resulted from a breach of a stored remediated nitrate salt-bearing waste drum.

- **Sandia National Laboratories:** In the past three years, Sandia National Laboratories has achieved corrective action complete status for 32 solid waste management units and areas of concern, which included industrial septic systems, drain fields, surface impoundments, open dumps, and firing and burn sites. This accomplishment has reduced the overall management of sites from close to 300 sites in the 1990s to six areas requiring corrective action; these six sites are undergoing continuing characterization and remedy efforts.

Site-Specific Issues

Efforts to modify how the volume of nuclear waste is recorded at WIPP continue. In December 2017, DOE published a modification to WIPP's permit with the New Mexico Environment Department in an attempt to change the way storage is tracked so that air and empty space in the underground storage area is not counted in the storage capacity with the waste.[93] The New Mexico Environment Department approved the permit modification in January 2019.

[93] New Mexico Environment Department. (n.d.). WIPP—permit page. Retrieved from https://www.env.nm.gov/hazardous-waste/wipp-permit-page/.

NEW YORK

West Valley Demonstration Project

Background

The West Valley Site (formally known as the Western New York Nuclear Service Center) is located approximately 25 miles south of Buffalo, New York (Figure 14). Pursuant to the federal West Valley Demonstration Project Act of 1980, the U.S. Department of Energy (DOE) is conducting a high-level waste (HLW) solidification and decommissioning demonstration project in cooperation with the New York State Energy Research and Development Authority (NYSERDA). DOE has operational responsibility for approximately 167 acres of the larger 3,330-acre Western New York Nuclear Service Center, all of which NYSERDA owns.[94]

FIGURE 14: Aerial view of the West Valley Site. Photo courtesy of U.S. Department of Energy.

From 1966 to 1972, Nuclear Fuel Services, Inc., a private company, reprocessed 640 metric tons of spent nuclear fuel to recover uranium and plutonium under agreements with the state of New York and a license issued by the U.S. Atomic Energy Commission (AEC). Approximately 600,000 gallons of HLW liquid and sludge resulted from reprocessing,[95] making West Valley one of only four sites in the DOE Office of Environmental Management cleanup complex with HLW — the other sites are the Idaho National Laboratory, Hanford and Savannah River — and the only site where DOE receives a state contribution for HLW vitrification and storage. All told, 60 percent of the spent fuel reprocessed at West Valley came from the N-Reactor at Hanford; the majority of the plutonium and all the uranium recovered at West Valley were transferred back to AEC.[96]

The Nuclear Waste Policy Act requires the federal government to bear the disposal costs of HLW resulting from atomic energy defense activities. Similarly, the only DOE disposal facility in the country open for disposal of transuranic (TRU) waste, the Waste Isolation Pilot Plant (WIPP) in New Mexico, accepts only defense waste. However, DOE considers West Valley a "commercial facility," despite the historical record indicating that a significant portion of the radioactive material coming to West Valley and most of the recovered material leaving West Valley was used for atomic energy defense activities, as defined under the Nuclear Waste Policy Act of 1982.[97] DOE's commercial designation for West Valley leaves the West Valley TRU waste without a viable disposal path. It may also strand the solidified HLW at West Valley as a result of DOE's insistence that the state pay an HLW disposal fee that could reach the billions of dollars.

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[94] U.S. Environmental Protection Agency. (2017, September 14). Hazardous waste cleanup: Western New York Nuclear Service Center in West Valley, New York. Retrieved from https://www.epa.gov/hwcorrectiveactionsites/hazardous-waste-cleanup-western-new-york-nuclear-service-center-west-valley.

[95] U.S. Government Accountability Office. (1980, July 28). *Nuclear issues at Western New York Nuclear Service Center*. Retrieved from https://www.gao.gov/products/112946.

[96] U.S. Department of Energy. (n.d.). 9. Plutonium acquisitions. Retrieved from https://www.osti.gov/opennet/forms?formurl=document/pu50yrs/pu50yc.html.

[97] U.S. Department of Energy, Office of Civilian Radioactive Waste Management. (2004, March). *Nuclear Waste Policy Act as amended*. Retrieved from https://www.energy.gov/sites/prod/files/edg/media/nwpa_2004.pdf.

Under the West Valley Demonstration Project Act of 1980, DOE is responsible for five activities:[98]

- Solidify the high-level radioactive waste.
- Develop containers suitable for permanent disposal of the solidified HLW.
- Decontaminate and decommission the HLW tanks, facilities used in the solidification, and material and hardware used in connection with the project in accordance with such requirements as the U.S. Nuclear Regulatory Commission may prescribe.
- Dispose of low-level waste (LLW) and TRU waste.
- Transport the solidified HLW to a federal repository for permanent disposal.

In 2002, after completing solidification of the HLW through vitrification, the West Valley Demonstration Project shifted its focus to decontamination and decommissioning efforts. DOE and NYSERDA jointly issued an Environmental Impact Statement (EIS) in 2010 and are conducting the decommissioning work in phases.[99] Phase 1, which will be completed by 2030, involves removal of the main plant process building, vitrification facility, contaminated lagoons, the source area of a strontium-90 groundwater plume and several ancillary facilities. To remove the main plant process building, the vitrified HLW that was stored inside that building was relocated to a new, on-site HLW dry-cask storage facility in 2016. The HLW vitrification facility was demolished in 2017-18; demolition of the main plant process building is expected to begin in 2020.

The Phase 2 decommissioning decision will be made through a supplemental EIS in the 2022-23 timeframe; it will identify the decommissioning approach for the HLW tanks, the nonsource area of the groundwater plume and two radioactive waste disposal facilities.[100]

Aside from the HLW issue and pursuant to intergovernmental agreements reached over the years, NYSERDA pays a cost share of 10 percent to 50 percent for cleanup costs.[101]

Major Accomplishments[102, 103]

DOE has worked with New York to achieve the following outcomes:

- Completion of the solidification of 600,000 gallons of HLW through vitrification.
- Transfer of the 278 canisters of HLW glass from the main plant process building to a new, on-site, interim dry-cask storage pad.
- Deactivation and demolition of the HLW vitrification facility.
- Removal of 6.5 miles of piping and 50 tons of process vessels from the site facilities, and shipment of more than 1.8 million cubic feet of low-level radioactive waste to off-site disposal facilities.
- Installation of an interim remedial measure to address the North Plateau Sr-90 groundwater plume.
- Stabilization of the Nuclear Regulatory Commission-licensed disposal area to limit water infiltration into the disposal holes and trenches.
- Effective and collaborative relationships with stakeholders, including local governments and the Seneca Nation of Indians.

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[98] U.S. Nuclear Regulatory Commission. (2018, November 2). West Valley Demonstration Project. Retrieved from https://www.nrc.gov/info-finder/decommissioning/complex/wv.html.
[99] U.S. Nuclear Regulatory Commission. (2018, November 2). West Valley Demonstration Project. Retrieved from https://www.nrc.gov/info-finder/decommissioning/complex/wv.html.
[100] U.S. Department of Energy, Office of NEPA Policy and Compliance. (n.d.). EIS-0226-S1: Decommissioning and/or long-term stewardship at the West Valley Demonstration Project and Western New York Nuclear Service Center. Retrieved from https://www.energy.gov/nepa/eis-0226-s1-decommissioning-andor-long-term-stewardship-west-valley-demonstration-project-and.
[101] New York State Energy Research and Development Authority. (2019). West Valley Demonstration Project. Retrieved from https://www.nyserda.ny.gov/Researchers-and-Policymakers/West-Valley/West-Valley-Demonstration-Project.
[102] New York State Energy Research and Development Authority. (2019). West Valley Demonstration Project. Retrieved from https://www.nyserda.ny.gov/Researchers-and-Policymakers/West-Valley/West-Valley-Demonstration-Project.
[103] U.S. Nuclear Regulatory Commission. (2018, November 2). West Valley Demonstration Project. Retrieved from https://www.nrc.gov/info-finder/decommissioning/complex/wv.html.

Site-Specific Issues

DOE's commercial designation for West Valley leaves the site's TRU waste without a viable disposal path and may also strand the solidified HLW at West Valley as a result of DOE's insistence that the state pay an HLW disposal fee that could reach into billions of dollars.[104] Historical site information documents the nuclear fuel complex activities that meet the definition of "atomic energy defense activities" under the Nuclear Waste Policy Act of 1982. NYSERDA is working with stakeholders and elected officials to formally establish the defense nature of the West Valley waste.

Relationship to Other Sites in the Complex

The West Valley Demonstration Project's relationships with other DOE EM sites are critical to completing the requirements of the West Valley Demonstration Project Act. These relationships include WIPP for the disposal of TRU waste and the Nevada National Security Site for the disposal of that site's LLW. In addition, ultimate disposal of the HLW stored on-site depends on decisions by DOE EM and the federal government about the establishment of an HLW repository for permanent geologic disposal.

[104] House Committee on Energy & Commerce. (2018, May 18). *Tonko remarks at nuclear waste legislative hearing* [Press release]. Retrieved from https://energycommerce.house.gov/newsroom/press-releases/tonko-remarks-at-nuclear-waste-legislative-hearing.

OHIO

Portsmouth, Fernald, Mound

Background

Ohio has three major U.S. Department of Energy (DOE) sites: Portsmouth, Fernald and Mound. Both Fernald and Mound successfully closed and transitioned to the DOE Office of Legacy Management (DOE LM) in 2006 as a result of the Accelerated Cleanup Program.

Portsmouth, also known as the Portsmouth Gaseous Diffusion Plant, is a 3,700-acre site located in southern Ohio. The facility was used to enrich uranium for fuel and weapons until 2001. A depleted uranium hexafluoride conversion facility, similar to the facility at Paducah, Kentucky, currently operates at the site. Large building complexes remain at the site and will require deactivation and decommissioning as well as remediation of soil and groundwater contamination.[105]

Fernald, now named the Fernald Preserve, is a 1,050-acre site located in southwest Ohio. It is a former uranium foundry that produced high-quality uranium metals for the nuclear weapons complex. Following years of cleanup, DOE EM declared closure of the site in 2006.[106] Ongoing activities at the site include continuing groundwater remediation, surveillance and monitoring of the on-site disposal facility, institutional controls implementation and other aspects of the remedy. Ohio settled litigation regarding natural resource damage that focuses primarily on contamination and lost use of a portion of the Great Miami Buried Valley Aquifer.[107]

Mound, a 306-acre site located in Miamisburg in southwestern Ohio, operated as an integrated research, development and production facility performing work in support of DOE's weapons and energy programs. DOE LM manages the site. Ongoing activities include groundwater remediation, groundwater monitoring and the implementation and monitoring of institutional controls.[108]

Major Accomplishments

DOE EM has worked with Ohio to achieve the following outcomes:

- In 2015 at Portsmouth, DOE EM finalized records of decision for the Process Buildings and Complex Facilities Decontamination and Decommissioning Evaluation Project and the Site-Wide Waste Disposition Evaluation Project. These decisions selected demolition of existing structures and disposal of materials that met waste acceptance criteria within an on-site disposal cell that will be constructed later.[109] Site preparation activities for the on-site disposal cell were initiated

[105] U.S. Department of Energy, Portsmouth/Paducah Project Office. (n.d.). Portsmouth. Retrieved from https://www.energy.gov/pppo/portsmouth-site.
[106] U.S. Department of Energy, Office of Legacy Management. (n.d.). Fernald Disclosure Project: About Fernald. Retrieved from https://www.lm.doe.gov/land/sites/oh/fernald_orig/aboutfernald/aboutF.htm.
[107] Ground Water Consortium. (2013). Great Miami Buried Valley Aquifer information page. Retrieved from http://gwconsortium.org/gmbva-information-page.php.
[108] U.S. Department of Energy, Office of Legacy Management. (n.d.). *Mound, Miamisburg, Ohio* [Fact Sheet]. Retrieved from http://westvalleyctf.org/2011_Materials/07/Mound_fact_sheet.pdf.
[109] U.S. Department of Energy, Portsmouth/Paducah Project Office. (n.d.). Portsmouth regulatory approach. Retrieved from https://www.energy.gov/pppo/portsmouth-site/portsmouth-environmental-cleanup/portsmouth-regulatory-approach.

in 2018, and decommissioning has begun on the interior of the large process buildings. In 2018, Ohio issued director's final findings and orders for the Comprehensive Environmental Response, Compensation, and Liability Act actions to restore natural resources supporting removal of landfills and plumes within the perimeter road.[110]

- Following remediation, DOE EM restored the Fernald site to native habitats, using the post-excavation topography to determine habitat type. The site is now a park focused on wildlife and managed by DOE LM. A visitor center opened in 2008.[111] More than 4,500 acres have been protected, with conservation easements and simple fee acquisitions within the watersheds surrounding the site as part of the natural resources damage settlement.[112]
- Since the Mound site became available for transfer in 2011, more than half of the original 306 acres have been transferred to new ownership. Currently, the Mound site has 16 businesses operating on the property with nearly 390 employees.[113] In 2014, DOE EM implemented an enhanced monitored natural attenuation field demonstration at Mound in an effort to transition the active groundwater pump-and-treat system to a more passive, monitored, natural attenuation remedy. The demonstration involves injections of edible oils to create in-place treatment zones.[114] After a one-year extension, the demonstration was completed in August 2018; recommendations are expected in spring 2019.

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[110] U.S. Department of Energy, Portsmouth/Paducah Project Office. (n.d.). Ohio EPA director's final findings and orders for CERCLA actions to restore natural resources. Retrieved from https://www.energy.gov/pppo/downloads/ohio-epa-director-s-final-findings-and-orders-cercla-actions-restore-natural.

[111] U.S. Department of Energy, Office of Legacy Management. (2014, July 10). *Fernald Preserve attracts 50,000 visitors*. Retrieved from https://www.energy.gov/lm/articles/fernald-preserve-attracts-50000-visitors.

[112] Ohio Environmental Protection Agency. (2018, June). *Fernald Natural Resource Trustees 2017 annual report to the public*. Retrieved from https://epa.ohio.gov/Portals/30/ffs/docs/doe/fernald/2017NRTAnnualReportFINAL.pdf.

[113] D Bush, J. (2018, June 7). Mound Business Park grows to 16 tenants, more companies likely on the way. *Dayton Business Journal*. Retrieved from https://www.bizjournals.com/dayton/news/2018/06/07/mound-business-park-grows-to-16-tenants-more.html.

[114] U.S. Department of Energy, Office of Legacy Management. (2014, July). *Field demonstration work plan for using edible oils to achieve enhanced attenuation of cVOCs and a groundwater exit strategy for the OU-1 area, Mound, Ohio*.

SOUTH CAROLINA

Savannah River Site

Background

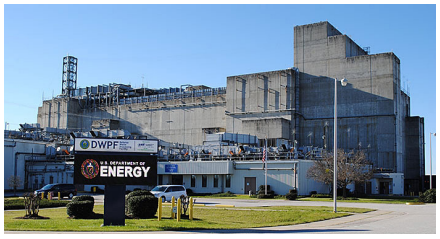

FIGURE 15: The Savannah River Site defense waste processing facility. Photo courtesy of U.S. Department of Energy.

The Savannah River Site (SRS) complex covers 310 square miles in South Carolina's Aiken, Allendale and Barnwell counties (Figure 15). It was constructed during the early 1950s to produce special radioactive isotopes (plutonium-239 and tritium) to produce nuclear weapons. After the Cold War, greater emphasis at SRS was placed on cleanup, but the site remains a major defense installation, with a continuing mission to process and purify tritium, uranium and plutonium. Savannah River is home to H Canyon, the only facility of its kind in the nation for processing nuclear materials. Because of past operations, more than 500 potentially contaminated sites and 14 groundwater contamination plumes exist at SRS.[115] Currently, the site's annual cleanup budget is about $1.4 billion. A consent order between the U.S. Department of energy (DOE) and the state addresses legacy mixed waste storage and treatment under the Federal Facilities Compliance Act. A Federal Facilities Agreement (FFA) among South Carolina, the U.S. Environmental Protection Agency and DOE addresses investigation and cleanup of contaminated sites at Savannah River.[116] In addition, relevant state statutes and regulations are applied to DOE EM cleanup activities, including treatment of high-level waste (HLW) and wastewater.

Accomplishments

DOE EM has worked with South Carolina to achieve the following outcomes:[117]

- DOE EM has made progress in the treatment of approximately 35 million gallons of mixed hazardous and radioactive HLW and closure of the aging storage tanks. As of 2018, eight tanks have been operationally closed—a third of the total old-style tanks scheduled for closure. The Defense Waste Processing Facility has produced more than 4,000 canisters, which is the equivalent of 156 million pounds of glass.
- SRS successfully added the interim salt disposition process in 2008 to augment treatment of the HLW. By the end of fiscal 2017, SRS had processed approximately 7 percent of the entire projected salt waste volume. Salt waste processing is an essential step in the closure of the HLW tanks because 90 percent of this waste is composed of salt waste. Savannah River has completed construction of the large-scale salt waste processing facility, which is slated to begin radioactive operations in 2019.
- Most of the legacy mixed transuranic (TRU) waste volume and mid-low-level waste (LLW) streams have been disposed of.
- At least 81 percent of 500 potentially contaminated sites at Savannah River have a cleanup decision in place in accordance with the FFA.

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[115] U.S. Department of Energy, Savannah River Nuclear Solutions. (2012, January). *Savannah River site* [Fact sheet]. Retrieved from https://www.srs.gov/general/news/factsheets/srs_esrs.pdf.
[116] U.S. Department of Energy, Savannah River Site. (1993, August 16). *Federal facility agreement for the Savannah River Site* (Document No. 89-05-FF). Retrieved from https://www.srs.gov/general/programs/soil/ffa/ffa.pdf.
[117] UU.S. Department of Energy, Savannah River Site. (n.d.). SRS news releases. Retrieved from https://www.srs.gov/general/news/releases.htm.

- To save time and money, DOE EM and regulators adopted an area closure approach rather than individual closures within the area. One example of area closure success is T Area in 2006, which included demolition of 28 buildings, off-site disposal of 91 cubic yards of soil and construction of a 10-acre geosynthetic cap. The project was completed in 36 months—48 months ahead of the original schedule.

Site-Specific Issues

Several site missions are ongoing at Savannah River, and their continuation and expansion are important to South Carolina. State officials are concerned about achieving cleanup and reducing legacy waste for the site to support future missions. The focus of the cleanup is on treatment and closure of the HLW tanks. The 35 million gallons of liquid radioactive and toxic HLW in aging and degrading tanks represent the single largest environmental threat in South Carolina.[118] Other concerns for the site include soil and groundwater cleanup, because SRS is in a uniquely humid area in which groundwater contamination can discharge relatively quickly into surface waters and subsequently the Savannah River.

In 1998, DOE designated SRS as the immobilization or conversion facility for much of the nation's surplus plutonium and began constructing the mixed-oxide fuel fabrication facility at SRS in August 2007. The facility is part of a nuclear nonproliferation agreement with Russia to dispose of 34 metric tons of weapons-grade plutonium by converting it into mixed-oxide fuel for use in commercial nuclear power plants. Although the mixed-oxide facility has been partially constructed, DOE has attempted to terminate funding for construction completion, prompting a lawsuit by South Carolina. DOE has considered other options for plutonium disposition, but questions remain about the feasibility, validity and timing of the considered options. DOE is required under federal law to remove from the state or process certain amounts of plutonium by certain dates.[119]

Relationship to Other Sites in the Complex

SRS will play a significant role in processing nuclear materials into the future. While it moves ahead with those missions, significant volumes of waste will continue to require treatment or disposal at other sites in the complex, including transporting TRU waste to the Waste Isolation Pilot Plant and spent nuclear fuel and vitrified HLW to an HLW repository. The vast majority of LLW (more than 55,000 cubic meters) at SRS will be disposed of on-site between 2015 and 2050, with the remainder destined for the Nevada National Security Site.[120]

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[118] AECOM. (2019). Savannah River remediation. Retrieved from https://www.aecom.com/ie/projects/savannah-river-site/.
[119] U.S. Nuclear Regulatory Commission. (2017, May 23). Backgrounder on mixed oxide fuel. Retrieved from https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/mox-bg.html.
[120] U.S. Department of Energy, Savannah River Site. (2015). *An overview of the Savannah River Site*. Retrieved from https://www.srs.gov/general/outreach/srs_info_pods/documents/srs_overview_2015_web.pdf.

TENNESSEE

Oak Ridge Reservation

Background

The Oak Ridge Reservation in eastern Tennessee consists of three major U.S. Department of Energy (DOE) facilities: the Oak Ridge National Laboratory (ORNL), the Y-12 National Security Complex and the East Tennessee Technology Park (ETTP) (formerly the K 25 Gaseous Diffusion Plant). Separate DOE offices—the Office of Science, the National Nuclear Security Administration and the DOE Office of Environmental Management, respectively—manage each facility. In the more than 60 years since the Oak Ridge Reservation was established, a variety of production and research activities have generated large quantities of radioactive, hazardous and mixed wastes. Historical waste management practices contaminated more than 500 locations on and near the Oak Ridge Reservation.[121]

Several agreements embody the regulatory framework at Oak Ridge Reservation. The 1992 Federal Facilities Agreement established environmental cleanup as well as restoration procedures and milestones.[122] A 1995 Tennessee Department of Environment and Conservation commissioner's order addressed mixed-waste treatment and storage at all DOE facilities at Oak Ridge Reservation, as established in the Federal Facilities Compliance Act.[123] In addition, relevant state statutes and regulations are applied to DOE waste management and cleanup activities.

Major Accomplishments

DOE's cleanup mission, in coordination with the state, has made progress on several cleanup and disposal activities, including:

- Shipping 5,952 depleted uranium hexafluoride cylinders off-site and elimination of the entire Oak Ridge Reservation inventory of legacy low-level waste (LLW).
- Closure of the compliance agreement between the state of Tennessee and DOE EM with the disposition of more than 7,700 containers of industrial, low-level and polychlorinated biphenyl-contaminated waste.
- Completion of the Uranium-233 Direct Disposition Campaign.[124]
- Shipping 1,105 cubic meters (m^3)—or 69 percent of the original inventory—of contact-handled transuranic (TRU) waste and 218 m^3—or 31 percent of the original inventory—of remote-handled TRU waste from Oak Ridge Reservation for permanent disposal.[125]
- Completion of Melton Valley interim Record of Decision (ROD) remedial actions by 2006.[126]

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[121] U.S. Environmental Protection Agency. (2018, October 23). Superfund site: Oak Ridge Reservation (USDOE): Oak Ridge, TN, cleanup activities. Retrieved from https://cumulis.epa.gov/supercpad/SiteProfiles/index.cfm?fuseaction=second.cleanup&id=0404152.

[122] U.S. Department of Energy, Office of Environmental Management. (n.d.). Federal facility agreement (FFA) signed at Oak Ridge. Retrieved from https://www.energy.gov/em/downloads/federal-facility-agreement-ffa-signed-oak-ridge.

[123] U.S. Department of Energy, Office of Environmental Management. (1995, September 26). Oak Ridge Reservation compliance order, September 26, 1995. Retrieved from https://www.energy.gov/sites/prod/files/em/2001_Agreements/ORR_CO_9-26-1995.pdf.

[124] Munger, F. (2016, April 28). The word on U-233 at Oak Ridge [Web log post]. Retrieved from http://knoxblogs.com/atomiccity/2016/04/28/word-u-233-oak-ridge/.

[125] Wilkerson, L., & Deacon, K. (2014, May 14). Transuranic waste processing update: Oak Ridge Site Specific Advisory Board. Retrieved from https://www.energy.gov/sites/prod/files/2014/05/f15/Transuranic%20Waste%20Processing%20Update%20-%20Laura%20Wilkerson%2C%20DOE.pdf.

[126] DOE EM Fact sheet "DOE Oak Ridge Environmental Management Program: Melton Valley Remediation Completed," April 2008.

- Demolition of all five former gaseous diffusion buildings at ETTP (buildings K-25, K-27, K-29, K-31 and K-33) and approximately 400 additional support facilities at ETTP.[127]
- Demolition of the Toxic Substances Control Act (TSCA) Incinerator.[128]
- Completion of design and initiation of construction for the Outfall 200 Mercury Treatment Facility at the Y-12 National Security Complex.[129]
- Initiation of liquid mercury and equipment removal at the Y-12 National Security Complex.[130]

Site-Specific Issues

Tennessee's primary concern is to ensure the protection of the health, safety and environment for its citizens given that Oak Ridge Reservation has an abundance of surface water and complex groundwater pathways. Tennessee, DOE and the U.S. Environmental Protection Agency are working together with stakeholders to address concerns about the proximity of the public to contaminated surface water and waste burials at DOE facilities in areas of abundant rainfall, shallow groundwater tables and karst hydrogeology.

Specific issues for the site include:

- Uncertainty regarding the long-term effectiveness of the hydrologic isolation of the Melton Valley burial grounds, where maintenance activities have been steadily increasing with downgradient trench issues and water levels inside the capped areas.
- One hundred miles of rivers and streams affected by historical site activities, including 250,000 curies of radioactive waste discharged into surface streams and 339,000 pounds of mercury discharged into East Fork Poplar Creek and the Clinch and Tennessee rivers.[131]
- Hundreds of acres of buried waste, including deep well injections, containing millions of pounds of uranium and several million curies of radioactivity.
- Hundreds of surplus facilities in deteriorating condition, some heavily contaminated with mercury and radionuclides.
- The need for characterization and evaluation of the extent of groundwater contamination, including delineation of exit pathways.
- The need for adequate characterization and segregation of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) waste necessary to maximize the available on-site waste disposal capacity.
- Selecting a protective CERCLA waste disposal option to support future cleanup, including limits on the types and volumes of waste disposed on-site.
- The feasibility of entombing highly radioactive salts in fuel drain tanks of the Molten-Salt Reactor Experiment at ORNL containing 12,780 curies of radioactive waste.[132]
- Lack of sufficient CERCLA project milestones to ensure a steady pace of cleanup.
- In addition to the issues above, current funding levels planned by DOE for Oak Ridge Reservation will extend the projected cleanup completion date.

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[127] U.S. Department of Energy, Oak Ridge Office of Environmental Management. (n.d.). East Tennessee Technology Park. Retrieved from https://www.energy.gov/orem/cleanup-sites/east-tennessee-technology-park.
[128] U.S. Department of Energy, Office of Environmental Management. (2018, September 11). Oak Ridge crews tear down TSCA incinerator. Retrieved from https://www.energy.gov/em/articles/oak-ridge-crews-tear-down-tsca-incinerator.
[129] U.S. Department of Energy. (n.d.). Outfall 200 Mercury Treatment Facility. Retrieved from https://www.emcbc.doe.gov/SEB/OF200MTF/.
[130] U.S. Department of Energy, Office of Environmental Management. (2018, November 20). Oak Ridge crews finish removing mercury-contaminated equipment. *EM Update*, 10(46). Retrieved from https://content.govdelivery.com/accounts/USDOEOEM/bulletins/21cd1dd.
[131] U.S. Environmental Protection Agency. (2018, October 23). Superfund site: Oak Ridge Reservation (USDOE) Oak Ridge, TN, cleanup activities. Retrieved from https://cumulis.epa.gov/supercpad/SiteProfiles/index.cfm?fuseaction=second.cleanup&id=0404152.
[132] Crocker, B. (2017, December 14). Contaminated molten salt reactor experiment may be entombed in concrete. *USA Today*. Retrieved from https://www.knoxnews.com/story/news/2017/12/14/oak-ridge-national-laboratory-molten-salt-reactor-experiment-may-cleaned-up-concrete/922963001/.

Relationship to Other Sites in the Complex

A ROD was signed in October 1999 to construct an on-site CERCLA waste disposal facility at Oak Ridge Reservation.[133] This facility is now about 70 percent full, and DOE EM is currently planning to construct a second on-site disposal facility for CERCLA cleanup waste. Even with this new on-site disposal option, off-site disposal alternatives are necessary for other waste streams, including TRU waste destined for the Waste Isolation Pilot Plant. Approximately 1.7 million kilograms of remote-handled TRU waste sludge and 930,000 kilograms of remote-handled mixed low-level aqueous waste stored in tanks at ORNL will require on-site treatment and eventual off-site disposal of the final form.

A 1993 consent order issued by the Tennessee Department of Environment and Conservation modified storage and treatment permits for out-of-state waste from DOE-owned facilities, and the TSCA Incinerator was used to treat DOE complexwide liquid and solid LLW contaminated with polychlorinated biphenyls. In addition, Tennessee has assisted New York by accepting low-level liquid waste from the Separations Process Research Unit for treatment and disposal. The agreement was in place for three years (May 30, 2012 to May 30, 2015) to allow for an on-site treatment facility constructed at the Separations Process Research Unit.

[133] U.S. Environmental Protection Agency. (1999, November 2). *EPA Superfund record of decision: Oak Ridge Reservation* (USDOE) EPA ID: TN1890090003, OU 13, Oak Ridge, TN (Report No. EPA/ROD/R04-00/028 2000). Retrieved from https://semspub.epa.gov/work/HQ/186989.pdf.

TEXAS

Pantex

Background

The Pantex Plant was originally built by the U.S. Army in 1942 on 16,000 acres in the Texas Panhandle, 17 miles northeast of Amarillo in Carson County, Texas. The Army used the site to load and pack conventional artillery shells and bombs in support of World War II. Today, the Pantex plant is the nation's primary facility for the final assembly, dismantlement and maintenance of nuclear weapons. The National Nuclear Security Administration (NNSA) also selected Pantex as the High Explosive Center of Excellence for developing, testing and fabricating high explosives components.[134]

Operations at Pantex are primarily conducted on 2,000 acres of the 18,000-acre site. There are approximately 650 buildings, and Pantex maintains its own water treatment, sewage and steam generating plants. Five wind turbines on the site generate enough power to support more than 60 percent of the plant's annual energy needs.[135] In April 2018, a new administrative and support facility named the John C. Drummond Center opened at Pantex. The three-wing complex accommodates approximately 1,100 administrative, technical and management staff who have been relocated from the aging 1950s-era facilities at Pantex as part of the modernization of the nuclear security infrastructure.[136] Eventually, the vacated buildings on the plant's site will be deactivated and demolished.

Historical operations at Pantex resulted in contamination of the soil and a perched aquifer beneath the site. A Record of Decision (ROD) was issued in 2008 with concurrence of the U.S. Environmental Protection Agency (EPA) and the Texas Commission on Environmental Quality (TCEQ) to address cleanup of the legacy contamination. The remedial action established in the ROD and the compliance plan in the hazardous waste permit include pump-and-treat and in situ bioremediation (ISB) technology for the cleanup of perched groundwater as well as soil vapor extraction for cleanup of nonaqueous phase liquids in soils. Results of the remedial actions are evaluated quarterly and annually and documented in progress reports to EPA and TCEQ. Pantex also conducts five-year reviews to evaluate the remedies and determine whether changes are needed to meet the cleanup goals and protect people and the environment.[137]

The agreement in principle between the state of Texas and the U.S. Department of Energy (DOE) supports the cleanup of the Pantex Plant and provides environmental oversight to protect human health and safety and the environment around the plant.[138]

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[134] Pantex. (2019). Pantex history. Retrieved from https://pantex.energy.gov/about/history.
[135] Pantex. (2019). About. Retrieved from https://pantex.energy.gov/about.
[136] Farris, J. (2018, April 6). Pantex unveils new administrative building. *Amarillo Globe-News*. Retrieved from https://www.amarillo.com/news/20180406/pantex-unveils-new-administrative-building.
[137] Babcock & Wilcox, Technical Services Pantex, LLC, & Sapere Consulting, Inc. (2008, September). *Record of decision for groundwater, soil and associated media. Pantex plant, Carson County, Texas*. Retrieved from https://pantex.energy.gov/sites/default/files/016005.pdf.
[138] Further information about the agreement in principle is available at Office of the Texas Comptroller of Public Accounts. (n.d.). Pantex: Agreement in principle. Retrieved from https://comptroller.texas.gov/programs/seco/programs/pantex/aip.php.

Major Accomplishments

All soil remedies are performing as designed. Interim actions included removal of more than 25,000 cubic yards of contaminated soil, construction of landfill covers, deactivation and demolition of facilities at major release areas, lining ditches near a major release area in Zone 12, and construction and operation of soil vapor extraction systems in Zone 11 and the burning grounds.[139] Only the burning ground soil vapor extraction was carried forward into the final remedial action established in the ROD. The soil vapor extraction systems have removed more than 19,000 pounds of volatile organic compounds since startup. Data indicate that the burning ground soil vapor extraction is nearing the end of remediation. Pantex is currently developing information to move toward shutdown of the remedial action system.

Pantex operates two pump-and-treat systems, with 72 extraction wells and two injection wells that are capable of treating at least 550 gallons per minute of contaminated perched groundwater. These systems are designed to remove and treat groundwater to reduce the saturated thickness of the perched aquifer and remove contaminant mass. The reduction in thickness will significantly reduce the migration of contaminants both vertically and horizontally to prevent them from migrating to the Ogallala Aquifer.[140]

The pump-and-treat systems at Pantex have treated more than 2.5 billion gallons of affected perched water, with about 14,000 pounds of contaminants removed by 2018. In addition, Pantex has beneficially used about 71 percent of the treated water. Saturated thickness is declining by about 1 foot per year in areas under the influence of the pump-and-treat systems.[141]

Three ISB systems have been installed at Pantex in locations where the confining layer of the perched aquifer is more permeable, the saturated thickness is too low (less than 15 feet) to be pumped efficiently or where ISB is effective in treating multiple contaminants of concern. The two oldest systems have treated high explosives, trichloroethene, hexavalent chromium and perchlorate near or below safe drinking levels throughout the systems. Pantex is continuing to refine injection to fully treat areas that have demonstrated only partial treatment. The third system will be injected for the first time in 2018.[142]

Site-Specific Issues

Since issuance of the Record of Decision, Pantex has evaluated the effectiveness of the remedial actions and found the plume of high explosive compounds in the perched groundwater continued to move to the southeast. In 2008, approximately 2.5 sections of land (i.e. 1,526 acres) were purchased from former Pantex neighbors to provide Pantex with ready access for perched groundwater monitoring and remedial action, as needed. To better control the continued southeast movement, Pantex installed wells to conduct pump testing in an area of sufficient saturated thickness and then installed an additional line of extraction wells on the purchased property in 2015 and 2016 to limit further movement to the southeast. Additionally, to better understand the extent of contamination, monitor wells were installed in 2016 and 2017 in the southeast portion of the purchased property. Results indicated the plume had moved through a

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[139] U.S. Environmental Protection Agency. (2018, October 23). Superfund site: Pantex plant (USDOE), Pantex Village, TX, cleanup activities. Retrieved from https://cumulis.epa.gov/supercpad/SiteProfiles/index.cfm?fuseaction=second.cleanup&id=0604060.

[140] Pantex. (2017, August). *Pantex environmental restoration: Perched groundwater pump and treat systems*. Retrieved from https://pantex.energy.gov/sites/default/files/P&Tfactsheet_2018.pdf.

[141] Consolidated Nuclear Security. (2018, June). *Pantex quarterly progress report: Remedial action progress*. Retrieved from https://pantex.energy.gov/sites/default/files/1Q2018_pantex_progress_report.pdf.

[142] Pantex. (2018, October). *Pantex environmental restoration: In situ groundwater bioremediation systems*. Retrieved from https://pantex.energy.gov/sites/default/files/ISBfactsheet_2018.pdf.

channel, or buried stream feature, to offsite property. Due to the limited saturated thickness, a new line of ISB injection wells was also installed at the property boundary to halt further movement of the plume to offsite property.[143]

Pantex is continuing to install wells on off-site property and use innovative technology to help identify the channel feature and the extent of contamination. Further well drilling is expected to occur in 2019 to attempt to delineate the plume. Pantex will continue to evaluate the contamination extent and viable options for cleanup of the plume that has extended off-site. Funding for this additional work will continue to be requested through the NNSA long-term stewardship program to address the issues southeast of the site.

Relationship to Other Sites in the Complex

Consolidated Nuclear Security, LLC, manages and operates the Pantex plant and the Y-12 National Security Complex in Tennessee under a single contract from DOE-NNSA.

[143] Pantex. (2018, October). *Pantex environmental restoration: Groundwater monitoring*. Retrieved from https://pantex.energy.gov/sites/default/files/GWMonitoring_FactSheet_2018.pdf.

WASHINGTON and OREGON

Hanford Site

Background

Located in southeastern Washington along the Columbia River, the 586-square mile Hanford Nuclear Site was the first and primary plutonium production facility for the United States' nuclear weapons program. The site, which began operations in 1944, includes nine closed reactors, five chemical separations plants, plutonium processing facilities, hundreds of burial grounds, more than 60 square miles of contaminated groundwater and 177 underground high-level waste (HLW) tanks containing 56 million gallons of highly radioactive waste.[144] Between the start of operations in 1944 and the shutdown of the last reactor in the late 1980s, Hanford produced more than two-thirds of the nation's estimated 111 metric tons of plutonium. The production of plutonium generated large amounts of radioactive and chemically hazardous waste. Currently, Hanford houses more than 60 percent of the nation's high-level radioactive waste.[145]

FIGURE 16: N Reactor at Hanford. Photo courtesy of U.S. Department of Energy.

Hanford is the world's largest single environmental cleanup project, with an annual cleanup budget of approximately $2.4 billion.[146] The shift from operations to cleanup came in 1989, when the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency and the Washington State Department of Ecology signed the Hanford Federal Facilities Agreement Consent Order, also known as the Tri-Party Agreement.[147] The Tri-Party Agreement outlines legally enforceable milestones for all aspects of cleanup at Hanford, including tank waste removal and treatment, mixed waste treatment and disposal, environmental restoration activities and low-level waste (LLW) disposal.

Major Accomplishments

Since 1989, much has been accomplished given the enormity and complexity of the contamination, including:

- Cleanup and disposal of more than 17 million tons of contaminated soil and building debris, much of it from liquid waste sites, burial grounds and nuclear facilities along the Columbia River corridor.
- Removal of spent nuclear fuel (SNF) from basins adjacent to the Columbia River.

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[144] Exchange Monitor. (n.d.). The Hanford Waste Treatment Plant: A 21st century solution to a 70-year-old problem. Retrieved from https://www.exchangemonitor.com/long-form-stories/the-hanford-waste-treatment-plant-a-21st-century-solution-to-a-70-year-old-problem/.

[145] Exchange Monitor. (n.d.). The Hanford Waste Treatment Plant: A 21st century solution to a 70-year-old problem. Retrieved from https://www.exchangemonitor.com/long-form-stories/the-hanford-waste-treatment-plant-a-21st-century-solution-to-a-70-year-old-problem/.

[146] Congressional Research Service. (2013, November 1). *Energy and water development: FY2014 appropriations*. Retrieved from https://fas.org/sgp/crs/misc/R43121.pdf.

[147] U.S. Department of Energy, Office of River Protection. (2019, January 21). Tri-party agreement. Retrieved from https://www.hanford.gov/page.cfm/TriParty.

- Shipment of more than 5,000 cubic meters of transuranic (TRU) waste to the Waste Isolation Pilot Plant (WIPP).
- Shipment of all weapons-grade plutonium for consolidation to the Savannah River Site.
- Installation of extensive pump-and-treat systems and chemical barriers along the Columbia River corridor and in the Central Plateau to reduce groundwater contamination and prevent contaminated groundwater from entering the river.
- "Cocooning" of six of the nine reactors to allow the radiation to decay. A seventh reactor was cleaned up and converted into a museum.
- Removal of most HLW from 17 aging single-shell underground waste storage tanks.

Site-Specific Issues

Washington and Oregon officials have sought assurance of adequate, long-term funding (through approximately 2070) to ensure that cleanup is completed, especially when work at most other sites is done. DOE EM estimates the remaining Hanford cleanup to cost well over $300 billion;[148] however, funding limitations put many cleanup milestones at risk and increase overall life cycle costs of cleanup.

Both the state of Washington's and neighboring Oregon's primary concern is the threat Hanford's legacy contamination poses to the Columbia River, which bisects the site. Much of Hanford's 56 million gallons of HLW is contained in 177 underground tanks. Approximately half of the 149 single-shell tanks have leaked, posing a threat to groundwater and ultimately the Columbia River if left in the tanks untreated. Current remediation plans call for construction of a vitrification facility — the Waste Treatment Plant — to treat the HLW.[149] Oregon and Washington remain concerned about construction delays, cost overruns and technical challenges plaguing the Waste Treatment Plant facility as well as the slow pace of waste retrieval from Hanford's aging tanks.

The full Waste Treatment Plant is not scheduled to begin operations until 2036, and that date is considered at risk. In the meantime, DOE EM is proceeding with plans to begin vitrification of a low-activity waste stream using a simplified and much smaller pretreatment facility. DOE EM is required to begin treating low-activity waste by 2023, though much remains to be done to achieve that goal.

Work is underway on several other important and expensive cleanup priorities, all of which have their own challenges. This work includes final demolition of the plutonium finishing plant; the transfer of 1,936 capsules of cesium and strontium from pool storage to dry storage; removal of highly radioactive sludge from a concrete basin near the Columbia River; and removal of highly concentrated radioactive waste from beneath a hot cell in Hanford's 300 Area, just a few miles from the city of Richland.[150]

Relationship to Other Sites in the Complex

Though much of Hanford's cleanup activities will occur on-site, waste and materials will need to be sent to other sites in the complex, including TRU waste to WIPP and SNF and vitrified HLW to a deep geologic repository. In 2000, DOE EM selected Hanford to receive potentially tens of thousands of shipments of LLW and mixed LLW from other DOE sites for disposal at the site; however, litigation initiated by the state of Washington resulted in a moratorium on most new waste shipments to Hanford until the Waste Treatment Plant is in full operation. That suit has to date effectively removed Hanford as an option for off-site waste disposal for other DOE sites.

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[148] U.S. Department of Energy, Richland Operations Office. (2019, January). *2019 Hanford lifecycle scope, schedule and cost report* (USDOE Doc. No. DOE/RL-2018-45). Retrieved from https://www.hanford.gov/files.cfm/2019_Hanford_Lifecycle_Report_w-Transmittal_Letter.pdf.

[149] U.S. Department of Energy, Office of River Protection. (n.d.). *Hanford Vit Plant: Protecting the Columbia River*. Retrieved from https://www.hanfordvitplant.com/protecting-columbia-river.

[150] Oregon Department of Energy. (2014, September). *Hanford cleanup: The first 25 years*. Retrieved from https://www.oregon.gov/energy/safety-resiliency/Documents/Hanford%2025%20Year%20Report.pdf.

Super Kukla Facility, Nevada Test Site. The Super Kukla nuclear reactor was constructed in 1964 in a remote area of the Nevada Test Site to explore the initial phase of a criticality, or nuclear chain reaction. Photo courtesy of Library of Congress, Prints & Photographs Division, HAER, Reproduction number HAER NEV,12-MERC.V,5-1

Conclusion

States affected by contamination from the nations' nuclear weapons complex cleanup have made a sustained commitment to achieving that cleanup over the coming years. States and DOE must work together to address challenges that affect multiple states in a holistic manner. The five major issues for states—jointly setting funding priorities, compliance with regulatory agreements, managing waste safely, improving communications and updating emergency response protocols—are interdependent. Budgets affect DOE's ability to meet its compliance obligations, waste management decisions drive costs, and the ability to meet milestones or manage waste effectively in the short term affects budgets and compliance in the long term. At the same time, a waste-disposal or budget decision at one site can affect cleanup progress at other sites across the complex. Communication processes and protocols are critical for resolving problems between states and DOE; for setting budget priorities, especially when compliance milestones are not on track; and for addressing emergencies.

The FFTF supports the idea that complex-wide decisions should have complexwide input from states and intergovernmental groups, including tribes and local communities. These decisions should be made with a clear understanding and transparent communication of the complexwide effects. It is important that states and DOE continue to address these issues simultaneously and in coordination so that cleanup can be accomplished safely, efficiently, and as fully as possible. Governors will continue to lead the important state efforts to achieve cleanup in coordination with DOE.

Appendix A. The History of the Nuclear Weapons Complex and Its Environmental Legacy

In 1942, the United States began to develop nuclear weapons technology under the U.S. Army Corps of Engineers' Manhattan Engineer District, known as the Manhattan Project. During the Cold War era, the United States significantly expanded its nuclear weapons program into a vast research, production and testing network that, at its height between 1945 and 1990, spanned 107 sites and 35 states and came to be known as the "nuclear weapons complex" (see Figure A-1 on the following page). The nuclear weapons complex would eventually produce more than 70,000 nuclear warheads of 65 types.

With the end of the Cold War and the collapse of the Soviet Union, the mission at many of the weapons complex sites began to wind down. The federal government and states have since reckoned with the environmental legacy produced by decades of intense radiologic activities. Most sites in the complex are contaminated with radioactive or other hazardous materials, such as solvents or heavy metals, often compounded by decades of active use. The contamination is found in buildings as well as soil, groundwater and surface water within and surrounding the sites. In 1992, Congress passed the Federal Facilities Compliance Act (FFCA). The FFCA gave states additional regulatory and oversight authority and required that the U.S. Department of Energy's (DOE's) cleanup adhere to federal environmental laws. Today, the DOE Office of Environmental Management oversees the cleanup effort.

1942	United States began to develop nuclear weapons technology, known as the Manhattan Project
1990	Nuclear weapons complex expands throughout the Cold War to span 107 sites and 35 states
1991	End of the Cold War and beginning of nuclear weapons complex cleanup effort
1992	Federal Facilities Compliance Act passed to give states regulatory and oversight authority
1995	Development of site treatment plans for all sites in the weapons complex
1999	Waste Isolation Pilot Plant opens as nation's first underground geologic waste repository
2003	DOE established LM to manage responsibilities after sites are closed
2005	Rocky Flats completed; largest environmental cleanup in the United States to date
2019	11 sites undergoing cleanup with a budget of $6.6B (in 2018 dollars)

What was once an employment boom to state and local economies during the years of nuclear weapons research, testing and production is now an environmental burden, and states bear some of the responsibility for the long-term cleanup of that legacy. This effort is the largest environmental cleanup program in the world and presents the 12 states most directly involved with numerous technical, financial and policy challenges. The federal budget for the weapons cleanup program is currently approximately $6.6 billion per year—one of the largest amounts for any federal program, including annual Superfund environmental expenditures. The total estimated cleanup cost for DOE's environmental liabilities is between $334.7 billion and $378.9 billion (in 2018 dollars), with cleanup anticipated to last into 2075.[151]

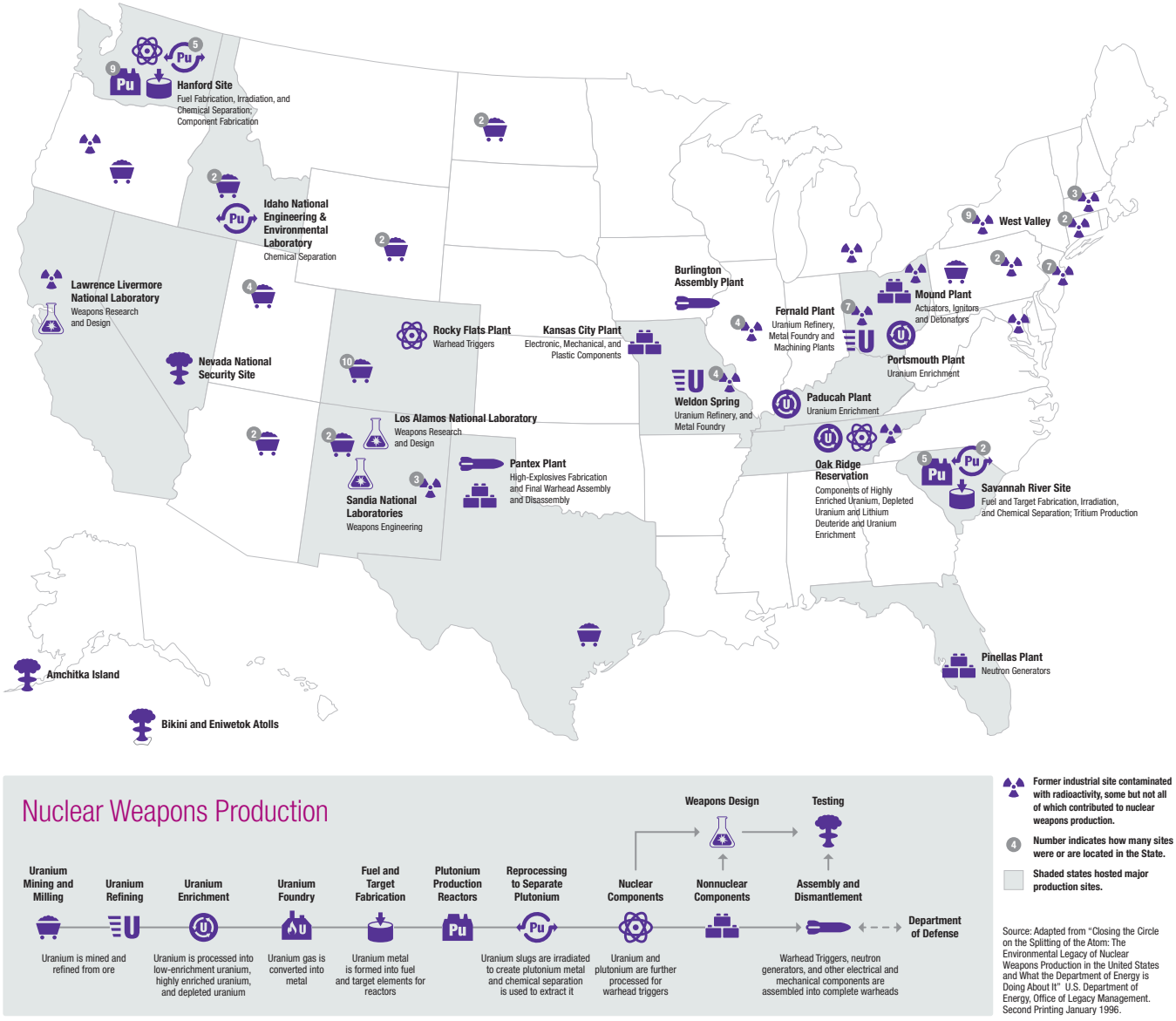

FIGURE A-1: Historic scope of the nuclear weapons complex at the height of its production capacity.

[151] U.S. Government Accountability Office. (2018, March 14). *Department of Energy: Continued actions needed to address management challenges* (Report No. GAO-18-438T). Retrieved from https://www.gao.gov/products/GAO-18-438T.

Appendix B. How Are Cleanup Decisions Made?

Federal Environmental Laws and Regulatory Authority

Since the 1980s, the U.S. Department of Energy's (DOE's) cleanup efforts have been subject to federal environmental laws and the regulatory authority of the U.S. Environmental Protection Agency (EPA) for certain activities. Many states have similar authority, partly through federal laws for clean water and hazardous waste that bestow oversight to the states. Cleanup decisions generally involve two main issues: the treatment of waste (through site treatment plans) and the disposal of waste (through processes that federal regulations determine). The following list provides an overview of the type of cleanup decisions made under each cleanup law:

Federal Facilities Compliance Act (FFCA) Site Treatment Plans. DOE, in close consultation with the states, completed treatment plans for each site in 1995. The plans are implemented under regulatory orders between DOE and the states and address only the treatment of radioactive waste. They do not directly address waste disposal. The development of the site treatment plans demonstrates successful collaboration between states and DOE.

National Environmental Policy Act (NEPA). NEPA governs the framework for many of DOE's waste management decisions. Within the NEPA framework, DOE uses environmental impact statements to make decisions and announces them in formal records of decision (RODs). DOE issued final RODs for its most common waste types, including high-level waste (HLW), transuranic (TRU) waste, low-level waste (LLW), and mixed LLW; those RODs are still in effect today. (See Appendix C for definitions of waste types):[152]

- RODs governing the management of HLW and TRU were issued in the late 1990s: HLW is intended to be disposed of in a yet-to-be-sited national geological repository, and TRU waste is disposed of at the Waste Isolation Pilot Plant in New Mexico.
- In 2000, DOE announced its final ROD for LLW and mixed LLW treatment and disposal sites. Each major site will treat its own LLW, while DOE continues (consistent with current practice and to the extent practicable) to dispose of on-site waste at sites that already have LLW disposal facilities (Hanford, the Idaho National Laboratory, the Los Alamos National Laboratory, the Nevada National Security Site [NNSS], the Oak Ridge National Laboratory [ORNL] and the Savannah River Site [SRS]). In cases where a site does not have on-site disposal capability or where specific waste does not meet waste acceptance criteria at the on-site disposal facility, DOE uses the NNSS for disposal of LLW. DOE also has the option of sending LLW to commercial, U.S. Nuclear Regulatory Commission-licensed or agreement state-licensed LLW disposal facilities.

[152] "Transuranic waste" is waste that has been contaminated with alpha-emitting TRU radionuclides. Elements that have atomic numbers greater than that of uranium are called "transuranic" (that is, beyond uranium). Because of the elements' long half-life, TRU is disposed of more cautiously than LLW. TRU waste is generally a byproduct of weapons production and consists of protective gear, tools, residue, debris and other items contaminated with small amounts of radioactive elements (mainly plutonium).

- DOE uses Hanford, the Idaho National Laboratory, ORNL and the SRS to treat mixed LLW from other DOE sites. DOE uses the NNSS for disposal of waste from off-site locations.[153] Under federal hazardous waste law, DOE must secure permits from the state to operate mixed LLW facilities.

Corrective Actions and Hazardous Waste Management at Still-Operating Facilities Under the Resource Conservation and Recovery Act (RCRA). The FFCA of 1992 reaffirmed the principle that federal facilities are required to comply with all federal and state hazardous waste requirements. DOE manages waste defined as hazardous or mixed (that is, waste that has both hazardous and radioactive components) under RCRA rules, and such waste requires ongoing safe management as well as corrective action to address release into the environment. Most states are authorized to carry out the federal RCRA program and their own state-specific requirements in their states. States make site-specific decisions about cleanup under RCRA corrective action authority in consultation with DOE, EPA and the public.

Waste Disposal Decisions Based on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Various site-specific decisions under CERCLA, also known as the Superfund law, address the disposal of contaminated soil, groundwater and buildings. Such decisions are made at the local site level in conjunction with state regulators and EPA based on land uses that reflect local conditions and, to the extent possible, the preferences of local stakeholders. CERCLA decisions must analyze, as appropriate, the tradeoffs between disposal on-site, off-site at a DOE disposal facility and off-site at a commercial disposal facility.

DOE Directives System

Within DOE, a series of directives, guides, orders and manuals specifies the details that govern how DOE and its contractors are expected to conduct environmental cleanup activities within the legal and regulatory frameworks described above. The DOE Directives System establishes how DOE policies, requirements and responsibilities are developed and communicated. DOE directives are the primary means of establishing policies, requirements, responsibilities and procedures for DOE elements and contractors. Topics addressed by DOE directives range from budget formulation to managing international commitments to records management. DOE guides provide acceptable but not mandatory means for complying with requirements included in directives. Guides cover a range of topics, such as performance measurement and biosafety facilities. DOE orders (including DOE Order 435.1, discussed earlier in this document) establish management objectives and responsibilities; manuals establish detailed requirements for carrying out the responsibilities of the order.[154]

[153] Currently, most mixed LLW goes to the NNSS disposal facility. Some also goes to commercial sites, and some on-site waste goes to a special CERCLA cell at Idaho National Laboratory.
[154] For more information, see U.S. Department of Energy, Directives Program, Office of Management. (n.d.). Directives, guidance, and delegations. Retrieved from https://www.directives.doe.gov/.

Appendix C. Waste Types and Definitions

	Waste Type	Destination
U.S. Department of Energy (DOE) waste	Low-Level waste (LLW) • Mixed • Not mixed	Nevada Nuclear Security Site (Nev.) Hanford (Wash.)* On-site disposal**
	Transuranic (TRU) waste • Mixed • Not mixed	Waste Isolation Pilot Plant (N.M.)
	High-Level waste (HLW)	To be determined
Commercial waste	Spent nuclear fuel (SNF)	To be determined
	LLW: • Class A • Class B • Class C	State compact system or licensed commercial disposal facility
	Greater Than Class C (GTCC) LLW	Federal law requires DOE to take title to GTCC waste. DOE is currently undertaking a programmatic environmental impact statement to determine a disposition location for GTCC.

* Not currently available for disposal of off-site waste.
** On-site disposal of DOE LLW (not mixed MLLW) occurs at Hanford, the Idaho National Laboratory, Los Alamos National Laboratory, the Oak Ridge Reservation and the Savannah River Site.

Definitions

Note: Definitions for DOE waste excerpted from DOE Order 435.1.

Low-level radioactive waste is radioactive waste that is not high-level radioactive waste, SNF, TRU waste, byproduct material, or naturally occurring radioactive material. Most LLW contains small amounts of radioactivity in large volumes of material. Some LLW, however, can contain significant levels of radioactivity. Low level does not necessarily indicate low hazard. Some DOE facilities dispose of LLW on-site.

Mixed waste contains source, special nuclear or byproduct material subject to the Atomic Energy Act of 1954, as amended, and a hazardous component subject to the Resource Conservation and Recovery Act of 1976. Mixed waste contains both radioactive and chemically hazardous materials.

Transuranic waste is radioactive waste that contains more than 100 nanocuries (3,700 becquerels) of alpha-emitting TRU isotopes per gram of waste, with half-lives greater than 20 years, with three exceptions:

- High-level radioactive waste.
- Waste that the secretary of Energy has determined, with the concurrence of the administrator of the U.S. Environmental Protection Agency, does not need the degree of isolation that the 40 Code of Federal Regulations (C.F.R.) Part 191 disposal regulations require.
- Waste that the U.S. Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 C.F.R. Part 61. TRU waste is generated primarily during the research, development and production of nuclear weapons. Most of the waste consists of such things as laboratory clothing, tools, glove boxes, rubber gloves and air filters contaminated with small amounts of plutonium and other radioactive elements. Some of these items will remain radioactive for tens of thousands of years.

High-level waste is the highly radioactive waste material that results from reprocessing SNF, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations as well as other highly radioactive material that is determined, consistent with existing law, to require permanent isolation. HLW is highly radioactive and must be isolated from the environment for thousands of years. DOE is currently considering revising its interpretation of the statutory definition of HLW as laid out in DOE Order 435.1. The proposed revision would interpret the definition as follows:

DOE's interpretation of HLW is that reprocessing waste is non-HLW if the waste:

I. Does not exceed concentration limits for Class C low-level radioactive waste as set out in Section 61.55 of 10 C.F.R., or
II. Does not require disposal in a deep geologic repository and meets the performance objectives of a disposal facility as demonstrated through a performance assessment conducted in accordance with applicable regulatory requirements.

Under DOE's interpretation, waste that meets either of these criteria is non-HLW and can be classified and disposed of in accordance with its radiologic characteristics.[155]

Spent nuclear fuel is nuclear fuel that has been irradiated in a nuclear reactor to the point that it is no longer useful in sustaining a nuclear reaction.

Class A (Commercial Waste) is radioactive waste that contains the lowest concentration of radioactive materials, most of which materials have a half-life less than five years.

Class B (Commercial Waste) contains the next-lowest concentration of radioactive materials, a higher proportion of such materials with a longer half-life.

Class C (Commercial Waste) has the highest concentration of radioactive material that DOE can legally bury in an LLW disposal facility.

Greater-than-Class C waste contains a concentration of radioactive materials that exceeds the limits for Class C waste specified in 10 C.F.R. Part 61.55. All GTCC waste is the responsibility of the federal government and must be disposed of in a geologic repository. Currently, no disposal facility exists for GTCC waste.

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[155] U.S. Department of energy, Office of Environmental Management. (2018, October 10). Request for public comment on the U.S. Department of Energy interpretation of high-level radioactive waste. *Federal Register*. Retrieved from https://www.federalregister.gov/d/2018-22002. Published 10/10/18.

Appendix D. Acronyms

AEC	U.S. Atomic Energy Commission
AMWTP	Advanced Mixed Waste Treatment Project
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
C.F.R.	Code of Federal Regulations
CIWG	Combined Intergovernmental Working Group
CNTA	Central Nevada Test Area
DOE	U.S. Department of Energy
DUF6	depleted uranium hexafluoride
EIS	Environmental impact statement
EM	Office of Environmental Management
EPA	U.S. Environmental Protection Agency
ETTP	East Tennessee Technology Park
FFA	Federal Facility Agreement
FFACO	Federal Facilities Agreement Consent Order
FFCA	Federal Facility Compliance Act
FFTF	Federal Facilities Task Force
ft3	cubic feet
GTCC	Greater Than Class C
HLW	high-level waste
ISB	in situ bioremediation
LLW	low-level waste
LM	Office of Legacy Management
LTS	long-term stewardship
m3	cubic meter
NEPA	National Environmental Policy Act
NGA	National Governors Association
NNSA	National Nuclear Security Administration
NNSS	Nevada National Security Site
NRDA	natural resources damage assessment
NYSERDA	New York State Energy Research and Development Authority
ORNL	Oak Ridge National Laboratory
RCRA	Resource Conservation and Recovery Act of 1976
ROD	record of decision
SNF	spent nuclear fuel
SODI	Southern Ohio Diversification Initiative
SRS	Savannah River Site
TCEQ	Texas Commission on Environmental Quality
TRU	transuranic
TSA-RE	Transuranic Storage Area-Retrieval Enclosure
WIPP	Waste Isolation Pilot Plant

Appendix E. NGA Solutions: Center for Best Practices Federal Facilities Task Force Principles and Associated Expectations for State–Department of Energy Engagement

The NGA Solutions: Center for Best Practices Federal Facilities Task Force (FFTF), established in 1993 with support from the U.S. Department of Energy (DOE) Office of Environmental Management, brings together governor-appointed representatives from states affected by the ongoing cleanup of sites used in the production, testing, and assembly of the U.S. nuclear weapons stockpile. Recognizing that cleanup funding is not likely to be sufficient to meet all milestones in state–DOE compliance agreements for the foreseeable future, in December 2011 the FFTF set out to create, in consultation with DOE, a set of principles to guide how state regulators and DOE would jointly approach the planning and prioritization of cleanup work. The FFTF approved the following principles on May 2, 2012, at the FFTF Spring Meeting in Knoxville, Tennessee. FFTF states participating in the meeting were *Idaho, Kentucky, Missouri, Nevada, New Mexico, New York, Ohio, Oregon, South Carolina, Tennessee, Texas, and Washington.* The principles were subsequently reviewed and re-affirmed by the FFTF in December 2017.

1. **States support a sustained, quality cleanup that protects human health, safety, and the environment and complies with state–DOE agreements**

2. **Open and transparent communication between states and DOE is essential for achieving successful cleanup**

   Expectations:

   - Issues that have complex-wide implications should have complex-wide input and planning.
   - The Federal Facilities Task Force should serve as a forum for discussions of complex-wide issues.

3. **State participation is a critical element of the DOE budget process and the establishment of environmental priorities**

   Expectations:

   - States expect DOE site managers to engage states in prioritization of projects to provide early support to the federal budget process to jointly prioritize projects.
   - States expect DOE to provide detailed information about the current planning year and out-year budget plans, consistent with each state's existing Federal Facility agreement(s) and other applicable statutory requirements.
   - States support a "risk plus other factors" approach to priority-setting, as defined in the Final Report of the Federal Facilities Environmental Restoration Dialogue Committee.
   - States expect a role in determining how risk and other factors are considered.
   - States expect DOE to provide information about environmental and human health risks posed by DOE sites both individually and complex-wide, together with information to judge the impacts of schedule/milestone changes on risk and life-cycle costs from site to site.

4. Proactive engagement between DOE and states is crucial when milestones or other commitments may be in jeopardy.

Expectations:

- Generally, states expect to be assured, before considering a delay in a cleanup agreement, that DOE requests a fully compliant budget and makes a good-faith effort to meet all milestones or other commitments.
- If DOE foresees any change (budgetary, technical, other) that it believes will adversely affect a milestone or other commitment, states expect DOE to initiate discussion with the host state (and adjacent state, if appropriate), well before failure to meet the commitment becomes unavoidable and in accordance with applicable Federal Facility Agreements.
- In cases where one or more FFAs would be impacted by changes in another state's cleanup agreement, states will seek, with DOE's assistance, to develop a common understanding of the requested change and any positive and negative impacts to both states. Those cases may involve equity discussions between the affected states and between states and DOE.
- States support a framework in which state-DOE discussions occur to determine if they can reach agreement on modification of milestones or other commitments. During the course of these discussions, states or DOE may also introduce other items for negotiation to offset a proposed altered commitment; such items may not necessarily be related to the proposed altered commitment, but determination of acceptable alternatives will be at the discretion of each state.

Appendix F. NGA Solutions: Center for Best Practices Federal Facilities Task Force

The NGA Solutions: Center for Best Practices established the Federal Facilities Task Force (FFTF) in 1993 to assist in the development of the initial Federal Facilities Compliance Act site treatment plans. The FFTF continues to support state efforts. The mission of the FFTF is to bring together governor-designated representatives with U.S. Department of Energy (DOE) officials to examine critical technical, policy and budget issues and improve coordination of major program decisions on a range of issues related to radioactive material and waste, including:

> **Transparency in the DOE decision-making process, particularly for waste treatment and disposal decisions.**
>
> **A safe transportation and disposal system for all types of radioactive waste.**
>
> **Sufficient funding for DOE to meet annual milestones in state-DOE compliance agreements.**
>
> **Long-term stewardship at sites where cleanup to unrestricted levels is not possible.**

Governors of each participating state designate one or ideally two representatives to serve on the FFTF. Appointments typically include one policy and one technical or regulatory representative, but these selections are at the discretion of each governor. Representatives usually come from one or more state agencies responsible for the oversight and regulation of hazardous waste, such as environmental protection, energy, or natural resources departments. The 12 states participating in the FFTF in 2019 are:

- Idaho
- Kentucky
- Missouri
- Nevada
- New Mexico
- New York
- Ohio
- Oregon
- South Carolina
- Tennessee
- Texas
- Washington

List of Governors' Representatives as of March 2019

Idaho

Garrett Bright

Hazardous Waste Permit Officer, Idaho Department of Environmental Quality

Mark Clough

Settlement Agreement Coordinator, Idaho Department of Environmental Quality

Kentucky

Brian Begley

Registered Geologist Supervisor, Kentucky Division of Waste Management, Department of Environmental Protection

Missouri

Branden Doster, P.E.

Federal Facilities Section Chief, Missouri Department of Natural Resources

John Jurgensmeyer

Director, Hazardous Waste Program, Missouri Department of Natural Resources

Nevada

Christine Andres

Bureau of Federal Facilities Chief, Nevada Division of Environmental Protection

Greg Lovato

Deputy Administrator, Nevada Division of Environmental Protection

New Mexico

Stephanie Stringer

Resource Protection Division Director, Environment Department

Eletha Trujillo

WIPP Coordinator, Department of Energy, Minerals, and Natural Resources

New York

Paul Bembia

West Valley Site Management Program Director, New York State Energy Research and Development Authority

Ohio

Jim Sferra

Southeast District Office Chief, Ohio Environmental Protection Agency

Oregon

Ken Niles

Assistant Director for Nuclear Safety, Oregon Department of Energy

South Carolina

Myra C. Reece

Director of Environmental Affairs, Department of Health and Environmental Control

Henry J. Porter

Chief, Bureau of Land and Waste Management, Department of Health and Environmental Control

Tennessee

Kristof Czartoryski

Environmental Consultant, Division of Remediation, Oak Ridge Office, Tennessee Department of Environment & Conservation

Colby Morgan

Deputy Director, Remediation, Tennessee Department of Environment & Conservation

Texas

Denise Brooks

Program Administrator, Texas State Energy Conservation Office

Washington

Alexandra Smith

Nuclear Waste Program Manager, Washington Department of Ecology

CLEANING UP AMERICA'S NUCLEAR WEAPONS COMPLEX

2019 Update for Governors

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